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Eos, Transactions, American Geophysical Union

Tectonophysics

PRIFERITIAL RITIES OF CONTINENT: A SOURCE OF OISTRACES TEPRARES (Cremor & Vink (Depaitment of Geologics) and Geo-phreical Echances, Echecaton University, Priscoton, new Jarcey, 051(4), V. Jeson Margaa and the last has timented and the continent of the sections, rarely arrors in ocaset casions. To expirit this year-sectial riting of continents we cospece the toral strangeh of different lithosphere we listed the continents of lithospheric stude with depth. Cooperisons at total arrangh inflect with depth. Cooperisons at total arrangh inflect with depth. Cooperisons at total arrangh inflect with depth. Cooperisons at total arrangh loficed with depth. Cooperisons at total arrangh loficed with depth. Cooperisons at total arrangh loficed with depth. Cooperison at factor of chras. Also, a thickness crust as an attree guida, any ricing court as an ocasionness in a band to be local alcoupth of normal continents houndary would prater a continental pathway. This results in the farmation of seasily continents fragments or steroplars, which once accreted bach to a continuot deriog subdoction are assoned at thicknesses associated with socure consequent thicknesses associated with socure consequent thicknesses associated with socure consequent of tratar riting solucion. This results in the tendency, described as the Vilson Cycle, ol sow orders to open along the satura where a forcar ocean hall closed. [Elifting, displaced terrange, lithosphere]

J. Geophys. Vas., b, Paper 180591 J. Geophys. Vas., b, Paper 11059

NSO Plata Toctopics SYLDENCE POR A ROTSPOT ORIGIN BY THE CAMPLIES LILANDS wall, 2325 Coerns Road, Hoos Jula, Havel

8. Masting (Basail Iontitata of Geophysics, University of Hausil 1915 Corra Road, Howalls, Havail 70522), D. F. Kittey, C. E. Maisley, J. J. Breghtso, O. Epp. A. Lasarelca, and D. Schwenk
The results of palausagnetic goochemisol, and cadiomatric studies of the Easters Caroliso leiends in the
western Pacilic ledicate that the leiends were formed
by a bosepot located oner the palausagnetic hattenen I
and il m.y.h.p. The leiends show a lionac progress too
of case agas from I a.y. in the sant [Kusais] to II
a.y. le the west [Truk]. The causics of volumetric
assurements, prochesical, and slaratelegical studies
suggest that the buspot source is wender and parhaps
has been actually dying during the time truk, Pompa, and
Kusais vace boing Gerned.
The shield-building sagness of the Carolius islands
cassist of a different lated alimits secles showing
mubile prochemical differences. The post-studienal
lavas are highly silica-underretucated and trugs
alternet—accitand supphifolics. The lotter were accupied
subsequent to the cusuation of the sale shield phase of
woltendies. The partography sad geochemical avolation
of Trub, Pomaga, and Bussis is strongly reminiscent of
that of the Rawkian chalp hospes, Carolius shieldbuilding lavas are compositiously sore similar to
Resection alkatic invas.
J. Geophys. Les., I, Papar 190591

SITO Structure of the Lilbosphere
DITERFLATE EXTENSIONAL TECTORICS OF THE RESTREE BASILLARGE INFERENCES ON STRUCTURAL STYLE FROM SELECTION
REPLECTION DATA, REGIONAL TECTORICS AND THERMALRECLARICAL MODELS OF MINITAL/NOTIFIE DEFORMATION
S. S. Balth (Separtment of Goology and Goophylics,
University of Stab, Sall Lake City, Wish, STI2-1183)
and S. L. Swide

University of Sish, Sail Lake City, Wash, \$8[12-113] and S. L. Freha.

The general lask of a correlation between caribquakas and outrions faulting in the interior of the heaters and outrions faulting our efforts to evaluate the geometry, abrustural slyle and eschanise of normal faulting characteristic of this region of introplate actessing. To address the problem of here interpreted over 1500 me of an Buster reficult of this contraction of the state of the

some epporantly obliqued with the position of the transfer accounts to the transfer accounts to the transfer accounts to the position of the Presented transfer accounts of the present the sea schoolsen, suggesting that pre-entating enables he was not to the present of extensive, he makes the influence of check of states and plantly like the sealer-kenge and Coloredo Piekets quality, the best provide constraints on the daph to the sealer-kenge of Coloredo Piekets quality, the sealer handles and the season of the sealer manufactured and that counts and took and the season of the sealer which must accorded place and health after the sealer manufactured according to the sealer to the sealer the sealer of the sealer that the sealer that the sealer that the sealer than the sealer to make the sealer to the sealer that the sealer than the sealer to make at the sealer than the sealer to make the sealer than the sealer to make at the sealer than the seal cel models of the continents orusi were calsolated to examing the possibility of abalico, quasi-plastic flow and fis influence on Faulfing in the exatern Bealm-Bange, the western Coloredo Yieteau sed the Middle Rody Noemtains. Our data and infar pretaintee have reveifed the following styles of Cessacio deformation; it sleep to fow-sogie dip, sowed fastling along the Yeseto fault; 21 iso-mapped the modifier on committee possibily essociated with soverent on prescribing fraute; 3) the concurrence of expension for countries possibly essociated with soverent on prescribing fraute; 3) the concurrence of expension of possibility assets of the first sea outside by low-to moderate-dipping plance and listric faults; model) at least three vaccines liy-stacked, gn schelon low-engin relisoidons in the aid-to apper-erusit that dip gently westerd from ~3 in besneith the Wasatch Flates to ~15 km at the Utah-Naveda border; these reflections are interpreted as normal detection thates to moderate-angle dipping Faults sound be easily reconcluded aith classic brittle failure theory, but the inimpreted lermination of porus) faults at or shows the dasper low-dogle reflections suggests the presence of shallow souse of ductile deformation that may have secommodated allp. An imperient observation, based on interpretations of catendo reflection provides as that their associated scarpe in spoonedlideid sections that the subsections that their associated scarpe in spoonedlideid sections and described the section of the Wasatch feet

Vol. 65, No. 25, Pages 401-408

MAGNETIC RECONNECTION In Space and Laboratory Plasmas (1984)

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June 19, 1981

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R. Giovanelli 1915-1984



Ronald Gordon Giovanelli, D.Sc. F.A.A., ar entinent Australian scientist in the fields of physics and astronomy, died after a long illness on January 27, 1984, at the age of 69.

After graduating from the University of Sydney, he spont 2 years (1937-1938) as a Research Fellow at the Commonwealth Solar Observatory (Mount Stromlo). It was here that he developed his life-long interest in solar optical astronomy and the theory of solar active regions.

It is perhaps unfortunate that his work in this field had to be postponed for some years while Giovanelli joined the original group of one scientists who were recruited by CSIR (now CSIRO) to establish the Australian National Standards Laboratory. He spent 1940-1941 at the U.K. National Physical Labora-vanelli in 1916 advanced a theory that the tory preparing for this task. Returning to Australia in 1941 he became deeply involved a scientific support of the war effort, particularly with respect to the production of opti-cal munitions and military problems of night vision. After the war he played an important part in establishing Australia's national staudards of physical measurement in the fields of opics, photometry, and colorimetry. In 1958 he was chosen as Chief of the Division of Physics of CSIRO, a position he held until 1974, when the onset of his long illness ne-cessitated his retirement from administrative

During this period, which spanned most of Giovanelli's working life, he carried a heavy load of lecturing and training solar physicists as well as the administrative duties and contributions to scientific societies. Nevertheless he formal time to pursue his main interest of optical solar astronomy and related theoretical problems of the solar atmosphere and interplanetary space. He set up nvodern obser-vatories, first at Fleurs near Sydney and later at Culgoora in northern New South Wales. He was responsible for much of the unique optical equipment including the 1/20 A filter of the sophisticated magnetograph.

These developments and the related theoretical work, published in roughly 100 pa-

pers, covers a wide variety of problems including extensive studies of the diffusion of light tilrough stellar atmospheres. However, Giovanelli had sensed, even as early as his Stromlo days, that the ninst interesting phenomena in the solat atmosphere are closely related to the magnetic fields extending through the solar surface. A fundamental feature of plasmas, including, of course, the solar atmosphere and its imerplaneary extension, is the interplay of energy forms between the energy of magnetic fields on the one hand and the kinetic energy of particles on the other. Following earlier observational studies of solar flages and their structural re-

Hare optical emission is from atoms excited by electrons accelerated in induced electric fields near nentral points in the evolving magnetic fields of supspots. This and subsequem publications in 1947 and 1948 introduced the concept that we now call magnetic reconnection (or magnetic merging or magnetic held annihilation). It is not necessary to stress the importance of this concept, which is the basic feature of nundern theory of sular and stellar flares as well as a number of important phenomena in the magnetospheres of the earth and other planets.

atinn with CSIRO as a Senior Research Fellow, spending much time in various observatories and other research institutes around the would. During this period his main re-search interest was the hasic problems of the origin of the solar magnetic helds and the activity cycle. This problem has been ourstanding for more than a quarter century, but for most of that time the observational data available was so limited and so inaccurate that a sound physical theory was not achievable. The so-called turbulent dynamo theory is almost entirely a mathematical edifice with most parameters simply guesswork. Giovan-elli undertook a careful investigation of the properties of the concentrated tubes of magnetic flux which make up most or all solar magnetic fields. His last papers, some unpublished, were directed at a refuration of the popular theory of the origin of solar magnetic fields and the advancement of an alternative based mainly on observational data and physical arguments.

After 1974, Giovanelli retained an affili-

Ron Giovanelli's contributions to science and technology extended far heyand his research work. In Australia and abroad he taught and lectured extensively and served on numerous commissions and in other capacities in scientific bodies. He helped in the growth of Australia's national measurement system by serving as a member of the Nation-

al Standards Commission from 1959 to 1976. In 1962 he was elected a Fellow of the Australian Academy of Science and subsequendy served on the National Committees for Astronumy, Space Research, the International Quiet Sun Years, and Snlar-Terrestrial Physics as well as on the International Relations Committee and Science and Industry Forum. He was largely responsible for the setting up in 1966 of the Astronomical Society of Australia and served as president from 1968 to 1971. He was active within the International Asymmomical Union, serving as president of Conntission 12 (Solar Radiation) from 1973

Ron traveled abroad frequently and made extended visits to many observatories, including those at Kitt Peak, Sacramento Peak, Arcetri, and Freiburg. Many of his happiest times were spent in Tucson and the sarrounding areas in Arizona, New Mexico, Colorado, and Mexico. Apart from the frequent occasions when we were in different countries, I worked closely with Rnn Iront 1967 to the day before he died. Ron was always accompanied by his wife Kath who was nearly as well known in the astronomical community as Ron himself. She was also well known in the art worlds of Sydney and Tucson and at one stage she interested Ron in the techniques of pottery. Some of the results are still to be found among the staff of Sacramento Peak Observatory

During Ron's last few days a happy note was struck by the arrival of the proofs of lds book Secrets of the Sun (Cambridge University Press), written for nomphysicists. I visited him in a lyospital intensive care ward to find him clated about his book and, incredibly, giving dictation for his last publication. His death, which he knew to be innovment, occurred the

This tribute was written by J. 11. Piddington, Division of Applied Physics, USIRO, Sylvey, Aus-

News

New Climate Center

A center to direct what has been called the most broadly based scientific effort to pretlict the world's climate has been established at Columbia University. The goal of the new tenter is to predict with increasing certainty specific climate changes around the planet over periods of decatles.

Formed by the Goddard Institute of Space Sciences (GISS) of the National Aeronautics and Space Administration (NASA) and the Lamont-Dolicity Geological Observatory, the new Center for Climate Research was launched by a \$1 million gift from the G.

Unger Vetlesen Foundation. Housed at Lamont in Philisades, N.Y., the center will draw upon the large earth-history database and preeminent geological and ocean science research work at the observatory and GISS. Scientists at the center will have at their disposal the most concentrated mans of relevant physical and observational data ever assembled for climate study, including the Lamont deep-sea sediment core library and NASA's luige array of atmospheric and satellite data.

"The Center for Climate Research will be a center of excellence in research. . . [and] will provide a more stable environment for research and education of young scientists," said Barry Raleigh, director of Lamont. "We intend the center to provide a highly visible source of the fundamental scientific work needed to support those who must make decisions in planning for the use of the world's energy, land, and agricultural re-

"At Lamont-Doherty, ocean chemists, physical and biological oceanogcaphers, dendrochronologists, palynologists, paleontologists, and geologists conduct research on past dimates, the coupling of the oceans and the ntmosphere, the effect of the oceans on mediating carbon dioxide in the atmosphere, the oceans as sinks and sources of heat, the time scales for exchange of heat and gases between the ocean and the atmosphere and a variety of related topics," Raleigh explained. "Their ob-servations and theoretical effects provide parameters needed to improve the computer models at GISS, which in turn suggest new experiments and observations. The synergis tic combination of Lamont Doherty and GISS scientists will be the cornerstone of a major

national effort in climatological research." We must sustain observational programs for a decade or two if the problems addressed here are to be solved, and so we will seek longer-term commitments of federal support instead of the usual 1-3 year grants

currently afforded," Raleigh said.

The initial gift of \$1 million has been pledged by the Vetlesen Foundation on a marching basis. Columbia University, of which the Lamont-Doherty Geological Obser Valory is a part, hopes to raise another \$3.5 million over the next few years to assure the

center of continuing activity. The rilion will endow a professorial chair and provide funds for scholarships, post-documal fellorships, senior scholars, equipment, and operating endowment. Gifts already have been made by the Weyerlaenser Campany, SOHIO, the Exxon Research and Engineering Company, and the Exxon Education Foundation NASA will provide litianeial support for post-doctor-

CO₂ Extracts Secondary Oil

Eighty to ninety percent (or more) of the petroleum in an oil field remains in the ground after conventional primary recovery is done and the wells run dry. Secondary recovery techniques that utilize injected natural gas nr water can, if successful, recover an ailditional 20-50% of the original oil in place, but usually most of the oil stays in the ground. In the past few years it has been iliscovered that injection of supercritical carbon dioxide could be effective in extracting as much as 95% of the oil in place. Major pipe lines to carry carbon dioxide from natural occurrences to oil helds are now being constructed according to a recent report by F. M. Orr and J. J. Tabor (Science, 224, 563-569, 1984). Billions of dollars are being spent to construct three major pipelines and facilities for injecting carbon dioxide into the ground in the West Texas Permian Oil Basin.

F. M. Orr, Jr., and J. J. Tabor point out that the potential goal and the target for en-chanced recovery techniques is large: "Of the more than 400 billion barrels uf oil discovered in the United States, around 300 billium barrels will not be recovered by standard methods." Carbon dioxide is relatively inexpensive and effective, even after pipeline costs. Today, secondary recovery is mostly done by water or steam injection. This recovery is used in half the U.S. oil production. In the near future, carbon dioxide could account for most of the United States produc-

It has been known for n long time that supercritical fluids, including carbon dloxide, are effective solvents. The mechanism in oil fields is more complex. When carbon dioxide is pumped into an oil field, viscosities, two phase regions in pseudoternary (and strictly metastable) space, and bulk oil composition (in terms of light- and heavy unflectile fractions) are important factors. Pure carbon di-oxide is not miscible with crude oil. In the simplest model it is constrained by a two phase region that can be transversed to a single phase if the process of separation by differing viscosity proceeds, which it will it the crude oil has the right composition. The oil composition is not at all binary (although it is convenient to think of light and heavy hydrocarbon fractions), the system is sensitive to pressure and temperature, but the analogy seems to be consistent with field and labora-

tory observations. Porc pressure and other pure phenomena are important in the field. as are factors such as viscous instabilities, and the effects of water. Orr and Tabor note that tests of the use of

carlion dioxide in a range of actual oil field reservoirs have been remarkably successful, including some thoulest with water. The amount of carbon dioxide needed to recover each barrel of oil was alson 2000 cubic leet. The availability of carbon dioxide will thus be a limiting factor in the large-scale use of the process at present. In the future it may be economic to use the carbon diuxitle that is now being vented to the atmosphere in now er plant and rehnery smoke stacks. Orr and Tabor state: "Despite the remaining uncerrainties in the predictions of CO2 flood performance, CO: supplies, and process economics, it is clear that large scale use of supercritical CO2 for enhanced recovery of oil is assured."—PAIB

In Congress: **Upcoming Hearings**

The following hearings and markups have been tentatively scheduled for the coming weeks by the Senate and House of Representatives. Dates and times should be verified with the committee or subcommittee holding the hearing or markup; all offices on Capito Hill may be reached by telephoning 202-224-3121. For guidelines on contacting a member of Congress, see ACU's Cuide to Legislative Information and Coutacts (Eas, April 17, 1984, p.

June 26: Hearing on contracts by National Oceanic and Atmospheric Administration for mapping and charting services by the Senate Commerce, Science, and Trans tion Committee and the National Ocean Policy Study. Russell Senate Office Bullding. Room SR-253, 10 A.M.

June 26 (tentative): Flearing un making the Coastal Zone Management Act (P.L. 94-370) consistent with state management plans (H.R. 4589) by the House Merchant Marine and Fisheries Committee. Longworth Building, Room 1334.

TBA: Mark up of legislation (H.R. 3200) amending the Safe Drinking Water Act (P.L. 93-523) by the Health and Environment Subcommittee of the House Energy and Commerce Committee: Time and room to be announced -BTR

Spring Streamflow

Rapid snowmelt and heavy mins caused one of the wettest Mays on record last month, although signs of a drier season were present in a few scattered areas, according to the U.S. Geological Survey (USGS), Department of the

Reflecting overall conditions, the combined

average daily flow of the nation's three major rivers was 30% above the long-term average for May, the USGS said in its regular monthly report on the nation's water resonnces. These rivers—the Mississippi, St. Lawrence, and Columbia-drain more than half of the 48 contermitous states, and their flows provide a useful check on the general status of U.S. water resources.

Of 172 USGS index streamflow stations surreyed in May, flows in 114 (55%) were well above average (in the upper 25% of longterm record). Streamllows at 51 viations (35%) were in the average range, while 17 stations (10%) were well below average (in the lowest 25% of long-term record).

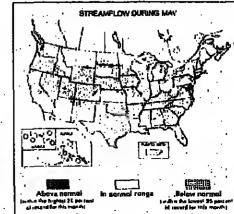
Record-high streamflows for the month of May occurred in 15 states: Columbo, Connecticut, Idaho, Iowa, Maine, New Jersey. New York, Kennicky, Nebraska, Nevada, North Carolina, Tennessee, Ut.di, Virginia, and Wyoning. Near-record high flows-one of the three highest flows for the period of recurd at each index station—occurred its eight states: Alabama, Florida, Georgia, Kansas, Mississippi, Minnesora, Oregon, and South Carolina.

Record-low or near-record-low streamflows were recorded only in Texas, Montana and Puerto Rico. At scattered points, however, streamflows declined into the well below-average range: in northern and southern California, in northern Washington and Idaho, in northern Michigan, in a small area of the lower Mississippi River Basin above New Or-leans, and in Hawaii.

Floods occurred in 14 states: as a result of snowmelt in Colorado, Idaho, Oregnu, Utah. Wyoming, and Nevada and as a result of heavy rains in Connecticut, Kentucky, New Jersey, New York, Oklahoma, Virginia, West Virginia, and Tennessee. Flood-related losses were greatest in Oklahoma when 12 inches of rain fell at Tulsa May 26 and 27. Flash floods occurred on two creeks in residemial areas, causing 13 deaths and \$250 million in dani-

Hydrologist Hai Tang at the USGS National Center in Restnn, Va., said ground-water levels tended to decline sensonally toward the

Naws (cont. on p. 412)



The VGP News



Eding: Bruce Doc. 11721 Dry River Court, Res-

Amazing and **Portentous** Summer of 1783

G. A. Wood

The summer of the year 1783 was an ancazing and paternous one, and full of hoarible phenome na; for besides the alarming meteors and tremendous thunder-storms that affrighted and distressed the different countles of this kingdom, the peculiar haze, or smokey fug, that prevailed for many weeks in this island, and in every part of Europe, and even beyond its limits, was a most extraordinary appear acce, unlike anything known within the memory of man. By my journal I find that I has notice this strange occurrence from Jone 23 to July 20 inclusive, thining which period the wind varied to every quarter without making any alteration in the alc. The sun, at noon, looked as blank as a docted muon, and shed a rust-coloured ferroginous light on the ground, and floors of torms; but was particularly locid and blood-coloured at rising and setting. All the time the heat was so intense that butchers' meat rould lear diy be eaten no the day after it was killed; and the flies swarmed so in the lanes and hedges that they rendered the horses half frantle, and riding irksome. The country people began to look with a superstitions are at the red, louring at pect of the sou; and indeed there was reason for the most enlightened person to be apprehensive; for all the while, Calabria and part of the iste of Sie ily, were forn and convulsed with earthquakes; and about that juncture a volcano sprung out of the sea on the coast of Norway. On this occasion Milton's oble timile of the son, in his first book of Paradise Lott, frequently occurred to my mind; and it is in-deed particularly applicable, because, towards the end, it alludes to a superstitutus kind of dread, with which the minds of men are always impressed by such scrange and unusual phenomena.

... As when the sun, new risen, Looks through the horizontal, misty air,

Shorn of his beams; or from behind the moon, In dim eclipse, disastrous twilight sheds On half the nations, and with fear of change

Two hundred years ago, White [1977], a vicar in the small village of Selhorne, England, noted a peculiar haze or smokey fog that dulled the sun but intensified the sum mer heat. The source of the haze was unknown to Wisite. However, the haze source was correctly inferred by his more renowned comemporary, Benjamin Franklin, as being a large emption at Laki, Iceland, White's little known ubservations of the haze provide details that prompt questions concerning cor-rect models of volcano-climate interactions.

Although the emption that caused the haze was the largest outpouring of lava in historic time, snicanologists have been slow to study it. Most of what is known comes from a preliminary report by Thoraring and USBAL the late dean of Teelandic volcanologists. Thorarinsum nieced together the sequence of events from field mapping at Laki and analysis of contemporary icelardic documents describing the emption. Following a week of earthmakes, an eruption began on June 8, 1783, near the mountain at Laki in southeast Iceland. Over the next 8 months, a 25 km line of explosion craters and lissures poured out nuire than 12 km of lava as well as prodigons solumes of CO2 and SO2. These gases ilirectly led to the worst famine in Iceland's history, by stunting the growth of pasturage and resulting in the death by starvation of 50% of the island's cattle, 79% of the sheep.

76% of the horses, and 24% of the people. It was prubably 11:5O1 actosuls from Laki that caused the haze commented on by hoth White and Franklin, During the summer of 1783, the haze ultimately spread to Europe, Asia, and even Alrica. Shrilar atmospheric phenomena followed the emptions of Tampora in 1815, Krakatau iri 1883, and, to a lesser extent, El Chichón In 1982. Accounts of the effects and dispersion of such fogs are valuable because they can lead to a better understanding of atmospheric circulation pat-

terns and volcano-induced climatic variations. There is abundant data and analyses of the Krakatau "dry fog" (summarized in Simkin and Fishe [1983]), some discussion of the famous "year without a summer" in 1816 following Tambora's eruption [Stommel and Stommel, 1983], but little mention, beyond Franklin's prescient speculation (reprinted in Eos, p. 601, August 10, 1982), on the origin of the fog of 1783. Thus, Gilbert White's vivid description of the atmospheric effects of the Laki eruption transcends the local hiatory

implant immense quantities of sulphuric acid

cron-size droplets absorb incoming solar radi-

priving the lower atmnsphere of a portion of the sun's heat. Measurements show that air

temperature averages 0.2°- 0.5°C lower than the normal for 1-5 years following major eruptions [Self et al., 1981], and lower tem-

peratures have been rommon in North

Anterica the 2 years since the El Chichón

sols titust rise into (nr form in) the strato-

sphere: otherwise, rain would wash acid

eruption. For this process tu work, the aero-

droplets out of the lower atmosphere. Thus, a cataclysmic explosion, like that of Krakaiau

place volcanic ash and aerosols high in the

upper atmosphere where they can be quickly

dispersed by stratuspheric winds over large

areas of the earth, causing widespread atmo-

The Laki event does not fit this explosive

pattern. The eruption was dominated by the

steady effusion of lava flows, with only minor

explosive activity producing a tephra deposit

of 0.85 km³ | Thorarinsson, 1969]. The meteo-rologist Lamb [1970] inferred that the ash vol-

time must have been 10 times larger to ac-

count for the pronounced atmospheric ef-

fects, but, actually, Thorarinsson seems to

have overestimated the true volume (S. Self,

personal communication, 1983). Thus, we are

left to conclude (as did Sigurdsson [1982]) that nonexplusive eruptions of sulphur-rich lava

flows may have as strong an effect on the at-

plosive blants, Additionally, I aummized that the HaSO4 needed to produce the character-

istic atmospheric effects associated with volca-

nism either does not have to be in the strato-

sphere or it can be injected there by leas dra-

The second alternative is possible, for mixing

across the tropopause does occur such that

the total mass of the lower stratosphere is re-

placed by tropospheric air every 1-2 years [Flohn, 1969]. Thus, some SOs from Laki

might have entered the stratosphere by nor-mal atmospheric mixing. For the Laki emp-

tion, however, historic evidence implies that

much of the sulphurous gases were in the troposphere. Limb's [1970] note that sulphurous smells and striping of the eyes were reported from various parts of Europe during

the period of the eruption demonstrates that

the lower atmosphere. This observation is

there were strong concentrations of H2SOs in

further evidenced by reports of plant claimage

in Holland in the early weeks of the eruption.

sphere because it was always present and was

Lanth doubts that the haze was in the tropo-

not washed out by rain. Perhaps, however, the continuing high rate of effusion (5000

ni 4s [Thuran nasun, 1968]] at Laki replenished

the haze as rapidly as it settled out of the at-mosphere. Indeed, 80% of the total volume

of lava land presumably gases) spewed mu during the first 50 days of the eruption

[Thoranimson, 1960], and the strangest atum-

spheric effects also occurred during the same

haze for only 1 month, cuinciding with the

period of strongest activity.

mmer mouths; Gilbert White abserved the

The eruption of Manna Loa that began on

March 25, 1984, provides a timely example of

tropuspheric transport of SO2 and attendent

atmospheric degradation. Acrording to early

personal continunication, 1981), by April 2 a

lawaii at least 5300 km to Guam, and visibil-

ity was reduced to 1.6 km at True and Wake

islands. This extensive and dense haze was

produced by degassing of less than 0.25 km³ of lava (estimated from extrusion rates). The

relatively large atmospheric effect due to the

small volume, short duration, and relatively low-effusion rate of the Mauma Loa eruption

pronounced haze extended westward from

reports (L. McClelland, Smithsonian Inst.,

matic processes than explosive volcanism.

mosphere and climate as do cataclysmic ex-

spheric effects.

Tambora, is an effective mechanism to em-

ation, and thus warm the stratosphere, de-

aerosnis in the stratosphere. These submi-

which Laki's sulphurous aerosols affected the climate are tentative; nonetheless the phenomenon did occur. If the emption of 12 kms of lava flows produced such noticeable atmospheric effects the relatively rapid emp-tion of the thousands of cubic kilometers of Columbia River basalts about 15 million years ago may have had a more profound effect. Is it possible that the colder and drier period of one small English village.
White's account of the "smokey fog" of 1783 is remarkably similar to descriptions of the Krakatau and Tambora hazes. As followfrom 14 to 12 million years ago that Axelcod [1981] ascribed to explosive volcanism was really a climatic result of the cruption of the ing thuse better known eruptions, the sun was dimmed, becoming "blood-coloured" at sunrise and sunset. The haze was unlike any Columbia River basalts? We do not know; but, clearly the Laki eruption is important for understanding at least brief climatic varianormal atmospheric fog, for it would not dis-perse with changing wind nr weather pattiona, and it may provide inaight into possible long term effects. Renewed study of the Laki eruption, its products (especially the volume erns. White's comments on the rapid spoiling uf butchers' meat and the profusion of flies of the tephra layer), and its atmospheric efare graphic evidence of the increased temfects are of first importance. Two hundred perature. All of these observations are someyears after the fact is not too late to start. Gilwhat unexpected because the Laki eruption does not fit the current idea of how volcanic pert White's delightful letter on the "amuzing and portentous" summer of 1783 could be eruptium influence climate. Considerable atthe first step in the geological and literary investigation of an extraordinary event. mospheric cooling and sunset glows following the eruption of Krakatan led to the idea that ash columns from large explosive eruptions

supports the contention that Laki and other

large nonexplosive cruptions (but presumably

These speculations on the mechanism by

cally important.

onstratosphere penetrating) may be climati-

I thank Mike Helfert and Alan Binder for reviews, Stephen Self for newa on the Laki eruption, and Lindsay McClelland for realtime information on the Mauna Loa erup-

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C. A. Wood is with the NASA Johnson Space

Understanding Thermal Energy and Mass Transport in Major Volcanic Centers

John F. Hermance An understanding of the thermal regions of the earth's interior and their associated dynamic processes is of central importance, not only to basic science but to a number of national priorities including resource and the mitigation of volcanic and earthquake hazards. Major thermal anomalies over large regions of the continent are associated with intraplate rifts and transform faults (e.g., the ion Trough and the Rio Crande Rift), disributed extensional tectonics (e.g., the Basin and Range Province), and plate margins (e.g., the Cascade Range). However, it is clear that of all classes of volcanic phenomena within the conterminous United States, the major intraplate silicic caldera complexes (e.g., Yellowstone, the Valles Caldera, the Long Valley/Mono Craters volcanic complex) appear to have, according to present estimates, the highest accessible geothermal resource base and the greatest destructive power during major eruptive phases. In addition, the exhumed fossil analogs of these systems are associated with extensive mineralization and economic ore deposits. What is lacking, however, is a predictive scientific theory describe

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ing the fundamental physio-chemical processes responsible for the development and longterm sustenance of these major volcanic centers in space and time.

Therefore, in response to a growing interest among earth scientists, gentechnologiest, and government policy makers, a coordinated research effort is being mubilized by the U.S. Geological Survey (USGS), the national laboratories, inclusion, and universities to develop a comprehensive understanding of the morphology and dynamical evolution of these major tectono-magmatic features. Of particular interest are questions regarding the transfer of energy and mass between magina reiervoirs deep seated in the crust and the shallower hydrothermal systems which they drive.

Rationale for Scientific **Experiments in Intermediate** and Deep Drillholes

Insight into the dynamics of these systems can be achieved by iterative use of various direct and indirect measurements tu refine conceptual and mathematical models. Approaches used to date include extrapolation of surface geology, interpretation of surface geophysics, direct measurements in shallow and intermediate-depth drillholes, inference from fluid geochemistry, and comparison with fossil magnia-hydrothermal systems.

Our understanding of the tutal system, however, is limited by our inability to sample more than the upper and couler parts of the active hydrothermal system itself. Although geothermal wells have been drilled to depth greater than 4 km and temperatures greater than 400°C, meaningful measurements are presently restricted to temperatures less than

Ideally, one would like to drill and carry out observations in the entire magnia-hydrothermal system, to magnitude temperatures, and to depths well within the crust. Although perhaps possible suincilay, at present it seemt realistic to restrict our objectives to temperatures of less than 410°C and to depths of leu than 4 km; in many cases this would allow one to study the "roots" of the hydrothermal systems. Direct sampling of this environment through drilling, while representing a dining challenge to present technology, would represent a dramatic improvement in our understanding of active physic-chemical processes in this regime not obtainable in any other

way. Information from a deep driffhule to a temperature of 400°C in a magnia-hydrother mal system would serve a number of purposes, only lour of which are identified here. 1. A complete characterization, from top to bottom, of the natural hydrothermal sys-

2. Evaluation of conceptual models for the evolution of the overall magma-hydro-

thermal system in space and time.

3. Quantitative parameterization of energy and mass transfer mechanisms throughout the total system.

4. Eviduation of interpretations from surface geophysical and geological observations. The drill-hole offers an opportunity to validate tlate and to refine surface techniques in what is essentially a "calibrated" environment. This would go a long way toward optimizing pre-drilling exploration activities in less-studied

Background on Potential Drilling Sites

Each of the three young, large silick vol-canic complexes in the western United States (the Valles caldera, New Mexico; the Yellowstone caldera. Wyoming; and the Long Valley caldera, California) has an associated hydrothermal system and has been subjected, in some degree, to a wide variety of earth sodrilling to intermediate depths (less than 2 kin). However, in none of the three areas do we have direct drill-hole knowledge of the roots of the hydrothermal systems (2-5 km) and how these hydrothermal aystems derive energy from molten rock sources within the earth's crust (from depths greater than 5 km). A number of workers concur that in choosing one or more of these calders complexes for deep driling, the following criter should be considered: (1) the system should represent an active counterpart of fossil cal-dera aystems; (2) a well-defined magma body should be present; (3) the target should represent a clearly defined stage in die evolution of sillcle centers; (4) a compete, compatible set of geological, geophysical, and internediate-depth drilling data should exist; (5) a significant area of the caldera should be available to desire. able to drilling in terms of both geographi accessibility and environmental sensitivity siting of the actual deep drill-hole(s) should be based on a reasonable certainty of encountering temperatures of 400°C on greater at depths of 5 kin; (7) drilling and maintain the drill-hole(s) should be technically feasible and (8) consideration should be given to the benefits from add-pri commercial drilling. holes (on the order of I kin, with one perhaps going as deep as 3 km) be drilled to berter quality (1) the magnia-hydrothermaltic model, [2] features within the intrusive aureole of the principal magma chamber, [3] the stratigraphic record within the caldera structure, or (4) the possibility of interstitial melt being still present at upper levels in the crust (i.e., above 10 km).

A preliminary evaluation of the three cau-

didate caldera systems, in terms of criteria

such as these, indicate that no single candi-

date system meets them all. On the basis of

available data, the Valles caldera might ap-

perature geothermal system at the Union

pear to be reasonably favorable, primarily be-

cause of the already demonstrated high-teni-

Baca hydrothermal site, the large amount of

intermediate-depth drilling by inclustry, and

the possibility (though not certainty) of good

access logistically. However, commercial drill-

ing in the area suggests that the required

hole may be extremely difficult to drill be-

cause of the underpressured nature of the

formation. This situation may be enroun-

tered in the other two candidate areas as well.

Such conditions may result in poor borehole

stability, and the hole may be lost while drill-

ing. Safeguarding against this exigency makes open-hole scientific experiments difficult. In

turn, the need to use sir or serated drilling

fluids increases corrosion and limits the abili-

ty to cool downhole equipment with the cir-

massive invasion of cement into the forma-

tion during cementing operations could pre-clude successful perforation of the zones of interest. In addition, the presence of cement

could lead to contamination of recovered

samples. These problems will cause higher

wells drilled elsewhere into hydrostatically

cents might be mitigated by chilling untside the Union Baca hydrothermal field on Re-

A recent workshop (Eas., June 28, 1983, p.

484) mulersrored the attraction of the Valles

ing since there exists a considerable back-

caldera as a site for continental scientific drill-

ground in regional and local geology, geo-physics, and geochemistry. In addition, litho-

ogic, geochemical, and thermal data have

been obtained from a number of intermedi-

ate depth holes within and around the 8aca

orediately outside the caltlera, where a hole

has already been drilled to 4.5 kut in base-

ment, encountering temperatures of 325°C.

To supplement these data, it has been recom-

mended that a number of intermediate depth

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Cover. Space shuttle photograph of an extensive SO₂ plume coming from the re-

cent cruption of Mauna Loa volcano, Ha

westward by tradewinds, reduced visibility

to only a few kilometers at many sites in

1783 due to a prolonged eruption at Laki,

Wood, NASA, Johnson Space Flight Cen-ter, Houston, Texas, See article in The

the western Pacific. This event was a

small-scale version of a massive tropo-

spheric haze that blanketed Europe In

Iceland. Shuttle photograph \$13-37-

1807. (Photo courtesy of Charles A.

VCP News entitled "Amazing and

Portentous Summer of 1783.")

waii. This tropospheric plume, carried

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Bell (News), Bruce Dne, C. Stewart Gillmor (History), Clyde C. Goad, Arnold L. Gordon,

geothermal field, as well as from the Hot Dry

Rock project on Fenton Hill at a location in-

pressured formations. Some of these con-

doudo dome or elsewhere in die caldera.

costs and risks for these wells than for similar

culating fluid. It must also be rerognized that

Yellowstone clearly represents the most intense magmatic and geothermal anomaly in the conterminous United States hat is an evironmentally sensitive area. Even for drill-hules declicated to purely scientific objectives, scientists and environmentalists are concerned regarding the potential hazard 10 geyser activity from any hydrologic ilisturbance. The CSDC has recendy established a task group under the direction of Bob Fournier of the USGS to study these issues further and to identify unique scientific questions that can only he addressed through drilling in Yellowstone. If drilling is recommended for this area, it will, of course, be for porely scientific reasons and with full regard for minigating any negative impact whatsoever un one of our finest national parks.

The thermal regime beneath Long Valley caldera is clearly dominated by hydrologic factors; unfortunately, however, unlike the case for the other two caldera, the hydrothermal system cloes not appear to have high temperatures at shallow levels. This in itself is a paradox and poses some intriguing scien-tific questions. Both geological and geophysi cal field evidence suggests the presence of a molecu magnia system at depths of only 8-10 km. Morrover, geochemical indicators suggest that the thermal waters, although now relatively low temperature, have derived from reservoirs where temperatures were as

th as 210%280°C In addition, recent tectonic deformation seismicity patterns, and the reactivation of fumarolic activity, caused the USGS to issue, on May 25, 1982, a notice that a potential volcanic hazard exists for the southwestern segment of Long Valley caklera. If, as has been proposed, magnia has intrided the upper crust of this area, surface geophysics in conjunction with borchole observations may be employed to monitor tectoric and magmatic activity associated with such a phenomenon.

An additional fartor to consider in the Long Valley area is that several young volcan ic systems Huyo, Mono, and Coso), which may he in a pre-caldera stage of evolution, exist along the eastern Sierra from nearby. Studying several of these geologically related but gengraphically separated, caldern systems at various stages in their evolution offers disfinet advantages over concentrating studies within a single member of these when complexes. By restricting studies to a single system, it may be difficult to sort out various stages of geologic overprinting which necurs as these complexes evolve.

Research Needs

One of the major problems in designing long-term drilling program and assigning drilling priorities in young silicic calderas is that the data sets on which site selections are based are not presently comparable for the three areas. Therefore, as a prehide to a deep drilling (i.e., greater than 4.0 km) at any site, a program of intermediate-depth drilling (1.0-1.0 kin), needs to be carried out imme diately in conjunction with geological, geo-chemical, and geophysical field studies at the surface in several of the candidate areas. These investigations, along with theoretical modeling of physical processes, will enable the long-term drilling objectives to be identi-fied more closely. Neither the scientific ratio-nale, nor the cost effectiveness of drilling versus amount of information recovered, have been articulated in terms of specific physiochemical models for this class of system. For example, it is not completely clear what phase of the evolutionary history of a magma-hy-drothermal system needs to be drilled for greatest understanding. Do we drill a young system in an early stage of development to determine the initial evolutionary ronditions, or do we drill a mature system in a late stage of development? What is the basis for decidng between one hole going to great depth (10 km?) in a single system or a number of intermediate-depth holes drilled into a single system or a number of holes drilled into several systems at various stages of development? It is clear to most workers that to address these issuea, geophysical and geochemi cal field studies, along with a program of intermediate-depth drilling (1-4.0 km), need to be intensified in these areas immediately order to determine which of these systems have identifiable magma chambers and to characterize as closely as possible the gross features of their hydrothermal systems. It is equally clear that the best way to

achieve this is to let the science coudnue to evolve within the interdisciplinary, multi-insti tudonal framework which has developed quite naturally. The role of the agenciesthe National Science Foundation, the USCS, Department of Energy, and Department of Defense-should be to minimize the artificial, though sometimes real, obstruction of good acience by institutional boundaries. We should get on with the business of having scientists talk to scientists regardless of the agency which octually funds individual proGroundwater **Transport:**

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Acknowledgments

Many of the ideas presented here have evolved through discussions with my col-leagues on the Thermal Regimes Panel of the CSDC and elsewhere. In particular 1 and grateful for the interaction I have had with Patrick Muffler, Bolt Decker, Dick Dondanville, Hugh Taylor, John Sass, Sam Varnado, Terry Gerlach, Harry Handee, John Culp, and Bill Lunt. Although I have gleaned ideas from these and other sources, the comments presented here are not to be taken as an official position of the CSDC nor of the National Academy of Sciences.

John F. Hermanic is with the Department of Geological Sciences, Brown Unicersity, Providence,

News & Announcements

IAVCEI Working Group on Explosive Volcanism

The working group (W.G.) will address basic problems and unanswered questions in the realm of explosive volcanism and its producis. Its primary functions are the organization of field and laboratory consortia, formal meetings, and the editing of special publica-tions. Through these means we propose to stimulate research and communication on ex-

The W.C. leas three main areas of interest: (1) pyrodastic deposits, including characterization, stratigraphy and tephrochronology;
(2) eruption mechanisms nd eruption dynamics, including geocliemical and geophysical studies, modeling of volcanic systems and depositional processes, and fluid dynamics (much of this work can be applied to volcanic hazard analysis); and (31 interaction of explosive eruptions and the atmosphere.

Hutery, Under sponsorship of the Interna-tional Union for Quaternary Research (IN-QUA), a Commission on Tephra existed until August 1982, with the late Sigurdur Thorar-insson as Honorary President. The Commission had reached its goals of com the utility of tephrochronology and tephra studies to the scientific community. It sup-ported publication of a World Bibliography and Index of Quaternary Tehbrock-world will be and x of Quaternary Tephrochronology [Westgate and Gald, 1974] and a meeting held in Iceland in 1980 [Self and Sparks, 1981].

Realization that research on explosive vol canism was rapidly expanding led the then secretary of die INQUA commission to propose that some members of the disband commission serve as a nucleus for a Working Croup on Explosive Volcanism within the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI). A proposal for creation of a working group was submitted to the IAVCEI Secretariat at the IUCC meeting in Hamburg, August 1983, The IAVCEI Executive Committee officially approved adoption of the W.G. at the

lamburg meeting.
The W.C. has a rotating membership, with 25 members and 35 rorresponding members. Membership will change to reflect the activi-

tiea being undertaken. Activities to date. Since formation of the W.G., it has met one of its goals in the Krakatau Symposium on Calderas and Associated

Volcanic Rocks, held at the 1983 AGU Fall meeting and through publication of an up-coming special issue of JGR on the same sub-

Future events with strong participation of the W.G. include (1) a workshop on blast de-posits, to be held at Mount St. Helens in Angust 1984 and (2) symposia, light trips, and publications on problems in plucatomagnatic valeanism, to be held at the 1986 IAVCEL meeting in New Zealand, Other under of interest, with no specified activities at this time, inclinde field workshops on submarine silicie volcanism, companer modeling of eruption phenomena, emption phenomena associated with kimberlites, and the effects of explusive volcanism on agriculture, bealth, commerce, and energy issues.

Further ideas for held workshops, topics for study, and inectings are welcome. If you have upinious on the subject, need information on the W.G., or wish to join as a member or corresponding member, please contact either Wolfgang Elston, Secretary, Geology Department, University of New Mexico, Albunergie, NM 87131, or Grant Heiken, W.G. leader, MS D462, Los Alamos National Laboratory, Los Alantos, NM 87545.

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Self, S., and R. S. J. Sparks, (Eds.), Tephra Studies, D. Reidel, Hingham, Mass., 1981, Westgate, J. A., and C. M. Cold, (Eds.) World Bibliography and Index of Quaternary Teph-rochronology, University of Alberta, Edmon-ton, 1974.

Meetings

Volcanic Blast Workshop

A workshop on Blast Eruptions and Deposits, Mount St. Helens, Wash., will be held August 13-17, 1984. Sponsors: IAVCEI working group on Explosive Volcanism and Its Products and USGS CVO. (Michael F. Sheridan, Volcariic Blast Workshop, Department AZ 85287 (telephone: 602-965-3760).

The major emphasis of the workshop will be to examine and discuss the products of the May 18, 1980, "blast" of Mount St. Helens and related exuptions. The topirs of the techulcul sessions include terminology, theuretical aspects of blasts, eruptive phenomenonology, characteristics of blast deposits, and volcanic risk of blast eruptions. Following the workshop, exeursions will be made to one or more uf the Cascade volcanoes.

Participation in the workshop will be limited to about 50 people who have at active research commitment to the understanding of "blast" phenomena and deposits. People whu would like to attend should submit a one page application letter with a statement indicating their past (or projected) research intereat in "blast" phenomena or deposits. About 10-15 papers on the main topics of the workshop will be luvited for presentation. Most of these papers will be collected intu a volume. for publication. Funding will be sought to support five or six students and an equal number of foreign scientists. All others must support their attendance through their own

end of May. Neverthelers, levels were generally higher than long-term averages for the

Tang said surface-water storage was at or abuve average at most reservairs. The New York City water-supply reservoin on the Delaware Siver were at 100% of capacity, as were Connectlent reservoirs at Bridgeport Hartford, Stamford, and Waterlury. In Arizona, the combined contents of Lakes Mead and Mohave were 32% above average; the Salt-Verile Reservoir System was 55% above average; and the Sao Carins Reservoir measured 255% above average. In California, combined contents of 10 index reservoirs were 5% almve average. In Oklahonia, contents of five of eight major lakes were above average for May.

In cooperation with nearly 800 federal, state, and local agencies, the USGS routinely gathers data un the quantity and quality of the nation's surface-water and groundwater resources at more than 45,0110 stations across

Fedlowing are additional details of the USGS check of the nation's water resources

Five Large Rivers: Average flows of the sucalled "Big Five" rivers were Columbia Siver at The Dalles, Ore., 223 billion gallons per day (ligit), up 30% from April and 19% lielow the long-term May average; Mississippi River at Vicksburg, Mits., US4 ligd, 72% alxive average and 10% greater than the flow in April; St. Lawrence River near Massena, N.Y., 198 ligh, a rise of 9% over April and 10% more than the mouthly average; Ohio River at Louisville, Ky., 144 bgil, 10% greater than the long-term monthly average and a 25% derline from the previous month; and Missouri River at Hermann, Ma., 133 bad. 123% above the usual May How and rlown 21% from April.

Connecticut: Above-average streamflows occurred across the state, with major flouds on the Connecticut and Housitonic rivers with recurrence intervals of 50-60 years (likely to occur only twice a century on the lung-term average). Near historic highs were set on Burlington Brook and the Pumperang

New York: Flows of all streams monitored by the USGS ranged from abuve average into the upper 25% of record throughout the states. Flows of many small streams were 2-3 times larger than average. Heavy rains May 28-31 caused fluods responsible for four deaths and \$1.5 million in damage.

Idaha: Flow of the Snake River at Weiser was in the upper 25% of normal for the 28ol. consecutive month. The average daily flow of 39.6 bgd was a new high since records began at the index station in 1910. Runoff from the recurd snowpack caused reservoirs to fill rapilly aint irrigation storage increased 11-15%,

to nearly average for the month.
Utah: Floods and flood threats declined toward the end of the month. They had come about as a result of significant increases of streamflows within the well-above-average range. The seven isdex stations tecorded streamflows 2.5 times larger than the 30-year average. The Colorado River at Gsco, Utah, reached 44.2 hgd May 27, the highest flow since 1917. The record-high average flow for the entire month was 27 bgd, which was mure than 3 times greater than usual for

The Great Salt Lake rose more than 8 inches during the month, to an elevation of 4,208.8 feet above sea level, about 2 feet 10 tion of 4,211.6 feet in 1873. Flow of the Surplos Canal at Salt Lake City reached a record-high of 2.66 bgd June 1, the highest since records began at the streamllow statiun 41 years ago. (Map courtesy of USGS, Res-

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Eas periodically lists in formation on recently accepted alactoral dissertations in the disciplines of geophysics. Faculty members are invited to enhant the following information on institution letterhead, above the tignature of the faculty advisor or department chairman:

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The Dynamics of Oragraphic Roin with large Latent Heat Release, Yuh-Lang Lin, Dep. of Geology and Geophysics, Yale Univ., May

The lo Plasma Torus: Its Structure and Sulfur Emission Spectra, R. J. Oliversen, Phys. Dep.,

Univ. of Wis., September 1983. The Marine Geochemistry of the Rare Earth Elements, H. J. W. De Baar, Mass. of Inst. of Tech., February 1984.

The Relotionship of Small Eorthquakes to Strain Accumulation Along Major Faults in Southern California, J. C. Pechmann, Seismological Lab., Div. of Geological and Planetary Sciences, Calif. Inst. of Tech., March 1983. The Shear Wave Velocity Structure in Northern

and Central California, A. R. Levander, Dep. of Geophys., Stanford Univ., April 1984.

Trace Elements and Radionuclides in the Connecticut and Amazon River Estnary, E. P. Dion, Dep. of Geology and Geuphysics, Yale Univ., December 1988.

Uplift and Cooling History of the NW Himolo-ya, Northern Pakistan—Evidence from Fission-Trach and Aris Ar Cooling Ages, P. K. Zeitler, Dep. of Earth Scl., Dartmouth Col-

lege, Hanover, NH, 1983. Wastewater Injection: Near-Well Processes and Thrir Relationship to Clogging, J. A. Ober-durfer, Dep. of Geolo, and Geophys., Univ. uf Hawaii, Mny 1988.

Geophysicists

B. Clark Burchfiel, professor of geology at the Massachusetts Institute of fechnology. was recently elected to the American Academy uf Arts and Science.

Hans M. Mark, sleputy administrator at the National Aeronautics and Space Administratiun, will leave his post to become chancellor of the University of Texas system effective September 1, 1984. Mark became deputy athninistrator 3 years ago. Previously, he had been Secretary of the Air Force from July 1979 until February 1981, and Under Secretary of the Air Furce from 1977. No permanent or temporary replacement has been appointed yet, according to a NASA spokesman. The president must nominate a successor, and the Senate must confirm the

Legislative Update

For additional information on these bills, contact the sponsoring Member of Congress or committee indicated. All congressional and committee offices may be reached by telephoning 202-224-3121. For guidelines on writing to a Member of Congress, refer to AGU's Cuide to Legislative Information and Contacts (Eas, April 17, 1981, p. 159). The lass Legislative Update was published in the May 8 Eas.—BTR

ARCTIC RESEARCH AND POLICY ACT, 11.8, 2292 (Young, Passed ARCTIC RESEARCH AND POLICY ACT, 11.8, 2292 (Volleg, R-Alaska) and S. 573 (Murkowski, R-Alaska), would provide comprehensive national policy dealing with national needs and objectives in Arctic and would provide a centralized system for collection and retrieval of scientific data, establish priorities, and provide financial support for basic and upplied at lemilic research. The House passed an amended version of the Senate bill, so S. 575 has been sent back to the Senate for approval of those House a member of the bill is sent to President rate 27, 1983 Reagan for his signature.

Awaiting com

COASTAL ZONE MANAGEMENT CONSISTENCY ACT, Awairing Hoor H.R. 4589 (D'Aniours, D-N.H.) and S. 2324 (Packward, R-Oreg.), would amend the Coastal Zone Management Act of 1972 to make federal activities conducted in the coastal zone consistent, to "the maximum extent practicable," with approved state management programs. Subcommittee on Oceanography of House Merchant Marine and Fisheries Committee repurted H.R. 4589 to full committee on May 3, 1984. S. 2324 was reported out of the Senate Commerce, Science, and Transportation Committee Jone 13, 1984.

EXCLUSIVE ECONOMIC ZONE IMPLEMENTATION ACT, Hearings to H.R. 2061 [Breaux, D-La.t and S. 750 (Stevens, R-Alaska], would Implement 200-mile EEZ adjacent to the U.S. territorial sea. Would also set forth U.S. policy on development and use of the natural resources and ocean floor. H.R. 2061 referred to House committees on Foreign Affairs, Interior and Insular Affairs, Merchans Marine and Fisheries, and Ways and Means, S. 750 referred to Senate Committee on Commerce. Science, and

EXPORT ADMINISTRATION ACT AMENDMENTS, H.R. 3231 (Bonker, D-Wash-) and S. 979 (Heinz, R-Pa.), defines restrictions on the export of scientific and technical information House passed its bill Oct. 27, 1983, and sent it to the Senate; it is on the legislative calendar there, S. 979 passed the Senate March I, 1984, and possed the House March 8, 1984. Conferences to iron out the differences were held April 12, May 5, May 22, Jone 14, and June 19, 1984.

LAND REMOTE SENSING COMMERCIALIZATION ACT OF 1984, H.R. S155 (formerly H.R. 4856) (Fuqua, D-Fla.) and June 8, 1984 S. 2292 [Gorton, R-Wash.), aims to establish a system to promole the use of land remote-sensing satellite data. Asserts that the private sector is best strited to develop land remote-sensing data markets and that cooperation between the federal govern-ment and the private sector should be initiated now to assure continuity of data and U.S. leadership in land remote sensing. A fully commercialized system should be pleased in gradually, ac-cording to the bill. The Senate passed an amended version of the House bill, so H.R. \$155 has been sent back to the House for approval of those Senate amendments before the hill is sen to President Reagan for his signature. Sec story in upcoming

MINING AND MINERAL RESOURCES RESEARCH INSTI- To be achied used Passed TUTE PROGRAM, H.S. 4214 (McNilly, D.Ariz.) and S. 2186 on Senate calco- April 9, 1984 (Warner, R-Vo.), would authorize funds for the establishment of nining and mineral resources research institutes in each state. Under the aegis of the Department of the Interior, each state would plan and conduct research and demonstrations and would train mineral engineers and scientists. Passed Flowse April 9, 1984. Senate Energy and Natural Resources ordered that the House bill override the Senate bill.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINIS-TRATION ORCANIC ACT, H.R. 5581 (Forsythe, R-N.J.). TRATION ORGANIC ACT, H.R. 5581 (Forsylle, R-N.J.), would establish NOAA as an Independent agency and as the agency primarily responsible for providing oceanic, rountal, and atmospheric services and supporting research (Faz. Sept. G. 1983, p. 557). Would also establish procedures to avoid duplication of effort in these fields among government agencies. Referred to two subcommittees of House Merchant Marine and Fisheries Committee and one of House Committee on Science and Technology. Several other bills that would establish a Department of Trade also call for making NOAA a separate agency. Merchant Marine Committee reported the bill out of committee April 10, 1984.

mittee April 10, 1984. NATIONAL OCEANS POLICY COMMISSION ACT OF

1985, H.R. 2853 JW. Jones, D-N.C.) and S. 1258 (Hollings, D-S.C.), would establish a 15-member commission that would develop recommendations for Congress and the President on a comprehensive national oceans policy. S. 1238 referred to Sen-ate Commerce, Science, and Transportation Committee.

PEER REVIEW REAFFIRMATION, H.Con.Res. 257 (Sensenbrenner, R-Wisc.), would reaffirm "due commitment of the Congress to award federal funds for scientific research projects and facilities solely on the basis of scientific merit as determined by a peer review process." Follows attempts by several universities to bypass peer review |Eas, January 5, 1984, p. 1). Referred to lution is sued to express principles and policy.)

SCIENCE AND MATHEMATICS EDUCATION, H.R. 1510 (Perkins, D-Ky.) and S. 1285 [Hatch, R-Utah]. H.R. 1310 allocated \$425 million for mathematics and science education in fiscal 1984 (Eas, March 22, 1985, p. 114). Senate bill, which also would authorize \$425 million, was reported out of the Senate Labor and Human Resources Committee May 10, 1985. The Senate debated its bill on the floor on June 8, 1984, but did not complete action.

SEVERE STORMS ADVISORY COMMITTEE ACT, H.R. 9207 (Hammerschmidt, R-Ark.), aims to assure that forecasting of severe storms within government agencies is coordinated for inaximum benefit. Would establish a committee of no more than 12 members that would recommend new programs, assess corrent forecasting programs, and make recommendations for incorporating new technology developments into the operational lorecasting system. Referred to a subcommittee of the House Science and Technology Committee.

YEAR OF THE OCEAN, S.J.Res. 257 (Stevens, R-Alaskn), Passed would designate the year beginning July 1, 1984, as the Year of June 8, 1984 the Ocean (Ess. June 19, 1984, p. 402). Referred to the House Committee on Post Office and Givil Service.

YEAR OF WATER, S.J.Res. 202 (Armstrong, R-Ohlol, would Passed designate 1984 as the Year of Water. Almit to increase awareness. Feb. 27, 1984. and dedication to the interests of worldwide water resources (Eas. March 20, 1984, p. 105). Referred to House Committee on Post.

Awalting com-

Awaiting fur-ther floor action March 2, 1984

No companion

Books

Role of Water in Urban Ecology

H. Hengeveld and C. De Vocht (Eds.), Elsevier. New York, 1982.

Reviewed by Neil S. Grigg

This volume is a report on a symposium or the role of water in urban ecology held in Amsterdam in August 1979. The second in ternational environmental symposium of the Koninklijke Nederlandsche Heide Maatschappij (Royal Netherlands Land Development Society) was cosponsored by the International Association for Ecology (INTECOLI and El-sevier Scientific Publishing Company with proceedings published in a special edition of the journal Urban Ecology, volume 6, pp. 1-362, from which this volume is reprinted.

Although there are contributions from a fairly wide cross section of scientists interested io the topic, the editors have done an un-usually good job of integrating diverse material into a romprehensive volume. Experts from a wide cross section of disciplines, geographical and language areas were asked to ribute materials on the symposium themes which were explained in advance in a shon paper by the editors. During the syntposium week, one comprehensive draft text was discussed rather than using individual papers. This procedure provided the opportunity from the beginning to create an inte-grated volume rather than a collection of dis

parate parts. The volume is organized into three parts.
First Is an introduction to the theme of urban ecology and the influence uf water. Then there are background chapters explaining the urban water aspects, the human aspects, the urban ecological aspects, water management and development, and planning in urban ar-eas. They are followed by four chapters with case studies; one relating to the design of bal ancing lakes in the new town of Milton Keynes, England; a second relating to water

in the new towns in the lisselmeerpolders of The Netherlands; a third case study of water lessons from Los Angeles; and a fnurth, a carrying capacity case study in Sanilel.

The term urban ecology refers to the ecosystem viewpoint where the city is as much a biological organism as it is a physical organum. Recognizing the complexities of the physical, biological, and socio-political compo nears of urban ecology, the organizers of the symposium sought to restrict the discussion by focusing on water. The result of the syntposium (and of the volume) is summed up by the editors when they state that few parts of the document can be used as a manual and that most parts have the nature of an introductory text. The text does not give, according to the editors, new factual knowledge for the specialist, but attempts to review and inlerrelate information from different disciplines. In other words, it is an interdisciplin ary view of a very complex set of problems. Most who have clealt with interdisciplinary efforts recognize the difficulties and shortcomings in trying to advance the state-of-the-art in any one area in a way that is scientifically satisfying. Because of this dilemma, the con-tributions of this volume are in the Integration of subject matter rather than in advancing the state-of-the-art at the frontiers of

The volume could be especially useful to those who seek to understand the urban ecosystem approach and the relationship with water resources. For example, the first chapter explains the interrelationships of water and human seulements and covers some of the background and development of urban

ecosystem concepts. Chapter 2 reviews the urban hydrological cycle and hydrological effects of urbanization and gives an international perspective of urban hydrology that might be seen as a literature review of the hydrological effects of ur-banization from a broad point of view.

Chapter 3 covers the human aspects of tirban water systems, a topic which has not been described in much detail in the engineering literature. This chapter includes a good discussion of the intangible aspects of eronomic analysis applied to urban water problems with a discussion of wants and needs, socio-economic thresholds, and willingness to pay and general psychological aspects of urban water utilization by humans in cities. This kind of information is very useful to managers and planners in understanding the intangible aspects of urban planning.

Chapter 4 covers nature and water in urban ecology, including a discussion of the ur-ban ecosystem with a biotic focus and a discussion of the influence of man on this blological community. This naturally leads into quasi-agricultural subjects such as soil and water management, leading on to discussions of pollution and biota in urban areas.

Chapter 5, covering water management, is the water planning chapter where techniques for flood loss and control and other aspects of urban water engineering are covered. Like ntroductory in nature, providing an over-

100

view of management possibilities. This type of material will be especially useful to the reader who is not well grounded in the sub-

Chapter 6, on development and planning, will be of special interest to those who are new to the field of water planning and who desire to learn about the linkages between land planning aml water planning. This

cliapter suffers from the same problem that plagues much of the planning literature: It is o full of charts, diagrams, and conceptual frameworks that many readers may woulder just what useful information is contained in the chapter

Chapter 7 begins the first case study which

focuses on Milton Keynes, a new town located in North Buckinghamshire, England, and the chemical and biological functions of "balancing lakes," which are generally called deten-tion ponds in the United States. The case study of the new towns in the IJsselmeerpolders located in The Netherlands is of simifar interest in that it is a view of the water management aspects of new town development including soils, environmental aspects. and hydrology. The difference, of course, is the bolder aspect of the new town development. The third case study relating to water management in California is entirely different because it addresses the problem of the super city ilrawing on water resources from all pans of the state to the detriment of the rural areas outside. The topic covers the history of water develupment for Los Angeles: the Los Angeles aqueduct system, the California State Water Project, and related political and engineering aspects. There is little discussion about the tirban ecosystem aspects of Los Angeles other than the influence of the development of Los Angeles on water sources in other parts of the state. The discussion of the City of Sanibel located in southwest Florida presents an example of development on barrier islands, a difficult and complex problem all over the world, including the United States. This presentation stresses the carrying capacity approach which relates to pulitical feasibility because of the appreciation of island residents of the sensitivity of their living

Overall, the volume delivers the manuscs of the editors; that is, it covers introductory subjects in some detail and constitutes a good literature review bin does not go intu great depth in any uf the topics. Some readers wil especially appreciate the literature review and the wide international roverage.

Neil S. Crigg is with the Department of Civil Engineering, Colorado State University, Fort Col-lins, CO 80523.

The Fluid Mechanics of Astrophysics and Geophysics: Stellar And Planetary Magnetism

A. M. Soward (Ed.), vol. II, Gordon and Breach, New York, 1983, xi + 376 pp.,

Reviewed by E. N. Parker

Stellar and Planetary Magnetium represents the proceedings of the Workshop on Planetary and Stellar Magnetism held in Budapest, Hungary, August 25–29, 1980. It is the second volume in a series on the fluid mechanic of astrophysics and geophysics, edited by P. H. Roberts. The first volume is Solor Flare Magnetohydrodynomics, with Eric Priest as volume editor. It is clear from reading both volumes that the overall editorial policy is one of exposition for an audience much broader than the experts that contributed the papers. Stellar and Plonetory Magnetism, like its predecessor, is as much a textbook as it is a topical review of the latest developments. The successive sections are devoted to dynamu theory, high conductivity dynamos and flux expulsion, solar magnetism, stellar magnetism, geomagnetism, and compositional convection, the last topic referring to the forces that drive the convection in the core of earth. In that respect there has been a question for years whether there is enough thermal enerreleased in the liquid core to drive convection and power the geomagnetic dynamo. It now appears that the slow cooling and solidificadon of the liquid core, to form a growing solld dendritic core at the center, is the most effective meants for driving the convection. The basic thermodynamics and hydrodynamics of this effect are presented with grailfying clarity and directness.

The volume begins with a comparative review, by H. K. Moffau, of the direc main approaches to dynamo theory, followed by two chaptera, by K. H. Rädler, discussing the general symmetries of the quasi-linear (first-or-der smoothing) approximation for the hydro-magnetic dynamo equations in the context of a spherical volume. The next five chapters treat a variety of auxilllary effects that arise chapters 1-4, chapter 6 must be regarded as introductors in the general hydromagnetic dynamo effects, such as flux expulsion from a network of convective downdrafts, the critical Reyn-

olds number for the moset of dynamo effects, and an unusual situation treated by S. Childress, involving intense witlely separated cyclonic eddies whose nutual magnetic interactions produce an extraordinary dynamu effect when their strength exceeds a critical

The remaining two thirds of the book is devoted to the Ilinid dynamics of the convective zone of the sun and other stars and the rore of earth, with specific application of the dynamo equations to the generation of the observed magnetic fields. M. Stix surveys dy namo action in late-type stars, while F. Krause reviews the classical magnetic A stars, showing that a dynamo origin of their fields is a possible and plansible alternative to the conventional view that the fields of the magnetic stars are primordial. A chapter is devoted to the possibility of dynamo action in accretion disks. There is an extensive discussion of what can be deduced about Iluid motions and magnetic Bux in the liquid core of earth from the abserved variations of the magnetic

held at the surface. It is interesting to look back over the theoretical and observational progress of the past 40 years toward understanding the origin, and sometimes erratic hehavior, of the magnetic fields of the planets, stars, and galaxies. A variety of alynamu effects have been discovered and described, and there has been a sold beginning on the dynamics of the convection within the rotating bodies that exhibit the magnetic helds. The limdamental obstacle to any "linal" theories is the simple fact that only the surface of the various bodies care be observed (with the exception of the galaxy) and the third rignantics of their con vective interiors is too complex (the Reynolds numbers are very large) a dynamical problem to permit a direct deduction of the motion from the inflace characteristics. The chargers in the sections on solar magnetism and geomagnetism delve into the problem, present-ing a collectice exposition of where knowledge presently stands and where it needs to go in the future. It is clear from Stello and Planetary Magnetism than the subject of stellar and planetary magnetism has come a long way, is developing rapidly, and has a long

E. N. Parker is with the Envico Ferms Institute, University of Chicago, Chicago, Illinou.

The Scientific Management of **Hazardous Wastes**

Cambridge Univ. Pren, New York, ix + 480 pp., 1983. C. B. Cope, W. H. Fuller, and S. L. Willers,

Reviewed by Keith S. Porter

According to the jacket of this book, three independent scientists carefully define the limits of scientific knowledge applicable to the management of hazardous wastes. It is claimed that the extrapolation and application of this knowledge is examined, signifi-cant areas of uncertainty are identified, and the authors reveal "the fallibility of certain interpretations." It would be more accurate to claim these as possible goals uf the book rath-

er than its accomplishments.

Chapter I, Hazardous Wastes and Their Recycling Potential, includes 11 pages of lists of chemicals, some of which are poorly reproduced. The remaining pages describe, super-

ficially, several recycling schemes. Connectinns between the chemicals previously listed and the recycling schemes are not given.

Concerning the potential for recycling, the
last sentence of the chapter reads, "Indeed, the concept of waste recycling, itself a contradiction in terms, is better politics than business." Taken literally, this assertion itself contradicts venerable practice, as the farmer might observe as he transfers waste from his cows to the erops in his field. More pertinently, it can be argued that the recovery of sol-

vents, metals, and oil from waste flows is

much more than a political gesture.

The following four chapters, accounting for one third of the book, review legislation of the United Kingdom. A reader may be at times confused about relevance of the material to hazardous wastes. For example, King Edward II's probibition of the casting of filth from houses in 1309 may have eliminated an unpleasant hazard to pedestrians beneath beilroom windows, but it hardly rorresponds to modern nations of hazardous wastes manment. It is interesing and useful to establish the context of pullution cuntrol within which hazardurs wastes are managed, but the links between the cuntext and the management should be explained.

Chapter 5 gives a brief overview of landfills and their leachates became, it is suggested, "the study of domestic refuse landfills and their leachates is an essential tirst step in understanding the problems which are encountered in the parallel held of hazardons waste management," Although this may be true, the reader is largely left to infer the implications for hazardous waste management.

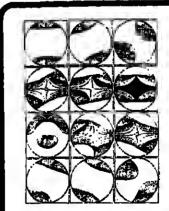
The next chapter describes landfills and codisposal of hazardous wastes but suggests that this practice capnot be condoned. It is also concluded that codisposal techniques and sanitary landfill practices are diametrically

Over one marter of the book it taken unby chapters 8 and 9, which describe, soil processes and toxicology, respectively. These are both primarily elementary summaries of basic scientific understanding. Again, the application of this understanding to the management of hazardons waste is loadequately develuped fur the reader. In the chapter int soil, the soil is described as something that "encapsulates the earth as undertal yielding to the foot; fullows earth's contours over the land, the surface of hill and valley, monomain peak and gorge, and under water of the lake. seas, and ocean in a thin rind that stands between life and lifelessness. Even to the poet, soil is that "nty sterious grit and gritne . . crumbling rock and decaying life, unce life. . abrading by wintl and water...weathering into soil—Mother Earth." To the farmer it equales to fruit and grains and catale. Tu the chemist soil characteristically is "rock on its way to the ocean." The geochemist may think of soil as the soft insoluble earth rind that turns solitble only to precipitate insoluble again as it follows in some reasonable ntanner

the pathway of thermodynamics" (p. 263). Efform of technical amhors to enliven their text with literary graces are to be particularly applauded. However, this and other passages in the book are careless and cause more discomfort thats pleasure. Literaty gems can be born out of aislikely "soil," but they will not shine withour much polishing.

The last three chapters outline options for treatment, disposal, risk assessment, and cost henefit analysis. For this reviewer, the two

Books (cont. on p. 414)



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best and most interesting chapters in the brink are those that discuss various methods of disputal ranging from solidification to incineration. These two chapters liest nieet the title of the book in describing directly the actual management of hazardosis wastes at least in the sense of rhisposal, to the sense of production, transport, and storage of hazardous wastes there is very little in the bank. Likewise, the management of spills and accidental discharges or emissions is also not directly

Overall, the brenk is marred by insufficient collesion and structure. Key questions in the management of hazardnus wastes are what hazardnus wastes are produced, how are they produced and in what quantities flow, when, and where are they dispused of, and what are the consequences and options? It might be objected that much of this knowledge is unavailable. The question in response would then be, What don't we know, how signilicam is our ignorance and what should be done? One of the most important uncertainties, facing the United States at lead, concerns the so-called "orphan" hazardons waste dumps for which there is little if any information. The scientific understanding that can be applied to the detection, characterization, and treatment of such hazardous waste sites so management priorities and responses can be made is not discussed in the lunk.

Finally, the bonk is marred by shoppy editing, uncharacteristic of the Cambridge University Press. For example, on page 249 we have "....the junic strength of the leachate falls from start to pays through a minimum around 200 days and then increases so that at around 350 days it is idmost equal to that in the first 50 days of operation. . . Nickel falls from 1 mg 1⁻¹ at 50 days through a minimum at 2011-250 days and then rises again to I mg 1-1 at 350 days," The first rd these sentences is gibberish. The second suggests some unconventional physics to account for "nickel falling through its minimum." Another probtem for the resider is that results are sometimes only vagnely or ambiguously cited. In querying one set of results, this tryiewer de-citled to check the source, which was a paper counthored by one of the authors of the book. The paper was found not contain the results credited to it. Such it ritations are not helped by minny technical lapses such as acine taxicity being referred to as "a single exposure of digration measured in seconds, minutes, or hours." In fact, acute exposure can be multiple.

In summary, this book has shortentings many if not most of which can be attributed in very poin editorial work. Despite the shortcumings, the authors convey a sense of having considerable collective experience applicable to hazardous waste management. The book contains a lot of information and at least would make background reading for those concerned with hazar dons waste man-

Keith S. Poster is with the Center for Environ mental Research, Cornell University, Ithaca, NY

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The Geophysics Group within the Oepart ment of Geology and Geophysics emphasizes research in the area of expluration methods. Equipment is available and operational for field operations in reflection selimic (DFS 111 and 1V). EMELIANT, MSAMin, Gent 8). (Pyllunice M.K.4, Phoenix 1PT-1, 2-5KW). for applications is June 22, 1984. Salary will be \$24,000—\$29,000/year depending upon education and experience. Applications with resume and names and telephone numbers of three references should be sent to: Otrector, Montana Burcaut of Mines and Geology, Nontana College of Mineral Science and Technology, Ottle, MT 59701, An EEO/AA Employer.

Faculty Research Assistant. Position is in the Department of Meteorology, University of Maryland, College Park. Opportunity to work will! faculty in a number of recearch studies involving climate modelling, satellite profilers, and mesoscale snalysis. Special emphasis on graphical ontiput from computer models, and diagnostic routines using meteorological data, including satellite and radar imagery. Graphics development will be done on a local microcomputer network and remote host computer. Applicant must be working currently in areas of Applicant must be working currently in areas of computer science, applications programming and meteorology. Bs in Computer Science or Meteorology required; MS desirable. Experience in FOR-TRAN essential; experience in UNIX, Pascal and Clanguage desirable. Appointment is for one year with renewal opportunity. Salary negotiable within range of \$18,000 to \$30,000. Contact Dr. David Rodenhuis, Department of Meteorology, University of Maryland, College Park, MD 20742; telephone 301-454-2708. Applications received before July 15, 1984 will receive full ronsideration.

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for travel and research, and the appointees will be encouraged to generate exterior support individually or through couperation with existing faculty. Please send inquiries, a vita, a list of referee, and a description of research interests to Edward R. Deceror Daniel R. Lux, Department of Geological Sciences, 110 Doardman Hall, University of Alaine at Orono, Orono, Maine 04489. Telephone calls may be made to 207-881-2152, and forwarded to Decker or Lux.

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Please send resume and at least three reference to Oirector, Marine Life Research Group, A.030, Scripps Institution of Oceanography, La Jolia, California 92093 by August 1, 1984.

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Research Assistant Professor/Shallow Water Simulation. A two-year, imn-tenure track appaintment is available at Oattmouth College. Primary emphasis is on retearch in hydrodynamic, and water quality amulation for esmarles, lakes, and coastal waters. The position also involves teaching one course per year. Additional opportunities exist for involventent in Grophysics, Numerical Methods, or Cold Regions programs.

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The Department of Oceanography in the College of Censciences at Texas A&M University has an opening for a Ph.O. with specialization in the field of seismic stratigraphy. This tenure track position is at the assistant professor level, Salary is negotiable depending upon experience and unalifications. This position will be available ponding final approval. The successful applicant will be expected to teach undergraduate courses in general occanography, a graduate course in seismic stratigraphy, and may develop graduate courses of his/her own design. He

or she will also be eparated to conduct a vigorous or sile will also be eparticle to the along with a letter research program.

Applicants should submit a rita along with a letter describing his/her research and leaching goals and the names of five persons for reference to Professor Robert O. Reid, Head, Department of Oceanography, Texar A&M University, College Station, Texas 77843. The closing date for applications it 15 July 1984.

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Research Araoclate/Research Technician. The University of Maine at Orono (UMO) has an opening for a research araoclate/research technician who would work in a small geophysical group. We seek an individual who can use and maintain modern digital electronic equipment; for example, multiclannel analysers, 1/0 interfaces for microcomputers, digital plotters and digitaring tablets. Familiarity with BASIC and FORTRAN will be needed, and some geophysical field work may be required as with BASIC and FORTRAN will be needed, and some geophysical field work may be required as part of the duces of the appointee. Current funding permits an appointment for at least 12 months. Subject to arrival of anticipated funding, the appointment period could be extended to two years, or longer. Call Edward R. Oecker at 207-581-2159 or 207-581-2152 about the position. Otherwise, send inquirtes, a vita and a list of at least three references to Edward R. Decker, Department of Geological Sciences, 110 Goardman Hall, University of Maine at Orono, Orono, ME 04469.

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GEOPOTENTIAL RESEARCH MISSION SCIENTIFIC CONFERENCE

A Geopotentiel Research Mission Scientific Conference will be held on October 29-31, 1984 et the University of Meryland. The purposa of the conference is to magnetic fields such as the Geopotential Research Mission is plenned to measura. The subject ereas of the conference ere:

Dynamics and structure of the sub-oceanic lithosphere. Dynamics and etructure of the continents Mantle convection

Oceen circulation in view of the diverse netura of the topics, it is plenned not to include measurement or dete enalysis techniques. There will be a number of invited papers but there will

be time for shorter contributed pepers or poster pepers. The conference will be co-chaired by W.M. Keule and C.G.A. Harrison.

Those interested in presenting e paper et the conference ere urged to submit an extended (2-3 page) ebstrect of their contribution by August 29, 1984. These, end enquirles concerning attendence at the conference should be addressed to:

Louis S. Welter Code EE-8 NASA Heedquerters Washington, D.C. 20546 Telephone: 202-453-1675

Dynamics of the core



The University of Manitoba Civli Engineering

WATER RESOURCES—SYSTEMS **ANALYSIS**

The Department of Civil Engineering is currently building en effort in civil engineering systems analysis, and hes an opening in water reacurces systems enelysis. The successful candidate will be expected to leach undergraduale and graduele courssa in weisr resources with a ayalems emphasis, as well as to establish a research effort in this area. A Ph.D. in civil engineering is required. The University encourages both

women end men to epply. In accordence with Cenedian immigration requirements, this edvartissmant is directed to Cenadien citizene and per-

The position is at the assistant professor level with an initial full time eppointment for e period of two years beginning Saptembar 1, 1965 or later. Plesse send e curriculum vilse, copies of recent publicatione, and the names of three referees to: Prof. H. Cohen, Head, Department of Civil Engineering, The University of Manitoba, Winnipeg, Menitoba, Cana-

Research Geophysicis/U.S. Geological Sorvey.

The Office of Earthquake, Volcame, and Engineering, Otanch of Tectomophysics is soliriting interest from pecsour with either a record of demonstrated ability or omistanding patential by research in one or more areas of Branch activity. The Branch of Tectomophysic vertices out a vigotomy program in the areas of crustal deformation, incrinastress and physical properties in regions of particular interest to earthquake and volcame hazards. Additional Branch activities include laboratory measurements of rock and mineral deformation in conditions appropriate to the crust and manile, The

with expertise in the aquitition, analysis, and interpretation of crustal deformation data.

All interested persons should submit a drapited resonne of chreatient, experience, summary of interests and recars is intention; and an appropriate salary level commensurate with experience by 20 July 1984 to: Wayne Thatcher

Branch of Tectonophysics

U.S. Geologicol Survey

343 Middlefield Road, MS 977

Menlo Park, CA 94025

Shoubla position become available in the Branch,

Should a position become available in the Branch, you will be notified of the competitive Federal employment application requirement.

Meetinas

Announcements

AWRA Conference

Aug. 12-17, 1984 20th Annual AWRA Conference and Symposium, Washington, D. C. (Kenneth D. Reid, Executive Oirector, American Water Resources Assoiration, 54111 Grosvenor Lane, State 220, Bethesda, MD 20814; tel.: 301-493-8600.)

The conference theme is "Overcoming Instinuional and Technical Constraints to Water Resources Management." The program features 17 technical sessions on such topics as institutions for managing regional water resources tytichis; data needs for analyzing the performance of water resources systems: models for coordination of water resources plans and programs; research to support im proved water management; regional water resources planning and management; state-federal relationships; assignment of responsi-bilities; and assessing the nation's water re-

The topic of the symposium is "Options for Reaching Water Quality Goals." The session will be keynoted by Rep. James H. Scheuer (O-N.Y.), chairman of the Subcommittee on Natural Resources, Agricultural Research, and Environment of the House Science and Technology Committee.

Chemical Oceanography

Aug. 13-17, 1984 Gordon Research Conference on Chemical Oceanography, Meriden, N. H. Chairman: William Sackett. (Alexander M. Cruickshank, Oirector, Cordon Research Conferences, University of Rhode Island, Kingston, RI 02881-0801; rel.: 401-783-4011.)

Among the topics to be discussed at this Gordon Research Conference on chemical oceanography are isotopic signals; carbon 14 and other tracers in the oceans; sulliur compounds and their cycles; marine chemistry; and biogeochemical processes.

William Sackett is the conference chairman. Robert Berner is the vice chairman. Oiscussion lesders include K. Turekinn, P. Quay, M. Andrea, E. Chidberg, and P. M. Williams.

Groundwater Models

Aug. 15-17, 1984 Conference on Practical Applications of Groundwater Models, Columbus, Ohio. Sponsors: National Water Well Association, International Croundwater Mudeling Center. (David Nielsen, Conference Coordinator, National Water Well Association, 500 Yest Wilson Bridge Rd., Worthington, OH 43085; tel.: 614-845-9355.)

The conference will feature contributed and invited papers on state of the art groundwater models and their practical apollcations. The conference will he structured to be informative to acasoned practitioners as well as novices in the field.

Organic Geochemistry

Aug. 20-24, 1984 Gordon Research Conterence on Organic Geochemistry, Plynomth, N. H. Chairmant: Kenth Kvenvolden, (Alexander M. Crnickshank, Director, Gordon Research Conferences, Univ. of Rhode Island, Kingston, R1 02881-0801; tel.: 401-783-

Among the topics to be discussed at this Catalon Research Conference on organic gen hemistry are the carbon cycle; geochemical biomarkers; humic substances; oil and gas detxisit occurrences.

Reith A. Kvenyohlen is the chairman of the conference. Robert H. Reitsenia is vice chairman. Discussion leaders are D.J. Des Marais, W.K. Scifert, G.E. Claypool, and P.G. Hatch-

Ophiolites Through

Nov. 13-15, 1984 Ophiolites Through Time. Nancy, France. (Jacqueline Oesinons, Université de Nancy 1, Faculté des Sciences, Laboratoire de Pétrologie, B.P. no. 239, F-54506 Vandoenvre-lès-Nancy Gedex, France.

The deadline for abstracts is September 1,

The conference will cover the evolution of ophiolites through time and its appraisal. The origist, chemical composition, petrographic equence, inferred mode of emplacement, and the structural environment of ophiolitic basic-ultrabasic associations from Proterozoic to Late Cenozoic ages will be compared. Reports on the radiometric dating of ophiolites, methods, and results will also be included. Oata permitting basic-ultrabasic associations in Proterozoic or Paleozuic paleosutures to be interpreted as ophiolites will also be welcome. As in former ophinlite conferences, an open sessions will be dedicated to contributions on

Quaternary of Virginia

Sept. 26–29, 1984 Symposium on the Qualernary of Virginia, Charlottesville, Va. Sponsor: Virginia Division of Mineral Resources, (S. O. Bird, Virginia Division of Mineral Resources, Box 3667, Charlottesville, VA 22903; tel.: 804-293-5121.) August 31 is the deadline for submission of contributed posters.

Among the topics to be covered are inte-quaternary climates of the middle Atlantic regioni Quaterniiry geomorphology in Virginia; Quaternary fossils; mainmalian extinctions; prehisioric and protohistorie large mainmal zoogeogrophy of Vitginia; and the study of Qualernary vertebrates in Virginia.

A field trip is planned for September 29 to
mammal and Indian sites at Saliville, Va.

The Geophysical Year calendar last

appeared in the June 5, 1984, issue of Eas.

Meetinga (cont. on p. 416)

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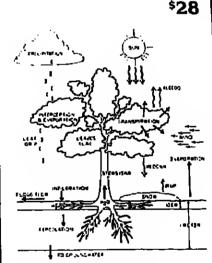
Meeting Report

The Pre-1958 Atmospheric Concentration of Carbon Dioxide

In considering the changes in the atmospheric concentration of carbon dioxide wrought by man's activities, it has been the practice to refer to some presuroed value of concentration in the late 19th century as the "pre-industrial" value. Implicit in many of these illscussions has been the assumption that prior to the significant use of fossil fuels, the concentration was more or less constant about this value and that fossil fuels were the main reason for the recent departures from it. A value of about 290 parts per million by volume (ppiny) was usually selected as representiative of the 19th century concentration. This value arose from a study by Callendar [1958], who examined a number of direct chemical measurements made then. If it is assunted that the fraction of fusall fuel produced CO2 remaining in the air was the same from 1860 to 1958 as it evidently has been since 1958, when systematic measurements began at Manna Lon Observatory, one calculates a value of about 295 primy for the late Dili century.

Recently, a number of studies have suggested a different picture. Not only may lower values of concentration be more appropriate but the assumptions of relative constancy of concentration in the 19th century, and of fossil fuel as the only major source, need to be reexamined. The evidence for these contentions was examined at a meeting in Boulder, Colo., June 22-25, 1983, sponsored by the World Climate Research Program, (The particinants are listed in the Acknowledgments and should be considered counthors of this report.) A full report of the meeting has been

Climate Processes and Climate Sensitivity (1984)



Geophysical Monograph Sedes Maurice Ewing Valume 5

J.E. Hansen and T. Takahashi, Editors 336 pages • hardbound • Illustrations

Throughout the fourth blennial Mautice Ewittg symposium, primary attention was given to fosteting an inderstanding of basic climate mechanians. The unifying emphasis of the symposium — and this ensuing proceedings volume — was a focus on climate feedback processes within a hroad range of time scales. The 30 scientific papers are organized into the conventinnal divisions of aimosphere, ocean, and cryosphere; each section bound together by the (eedback process.

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The meeting addressed chemical measurements in the 19th and early 20th centuries, some findings from examination of 1900-1950 spectroscopic tlata, records from ice cores, carbon isotopes in tree rings, and eviilence from indirect chemical measurements in the ocean. These will be discussed below as well as some of the implications of the findings. Finally, there were some recommendations for pursuing these techniques.

issued [World Climate Research Program, 1983]

and is available from the WMO Secretariat,

There are several reasons for wishing to have a record of atmospheric CO2 concentrations prior to the beginning of the systematic measurements in 1958 using nondispersive infrared techniques [which are not direct chemical measurements). A much longer record would be of considerable assistance in nping and validating carbon cycle models. Such mottels will be needed to estimate future concentrations of CO2. Climate models would strongly benefit from a longer record to assist in verification studies. A concentration significantly less than 290 ppmv would imply that fossil firel use has not been the unly significant contributor to the increase. A lower concentration suggests that any contrition to dimate change since the 19th century due to CO2 has been larger than would e been the case had the concentration been higher. On the other hand, a lower concentration would suggest a lower climate sensltivity to CO2. These implications will be discussed more fully below.

Early Chemics! Measurements

There were a number of independent mea surements of atmospheric CO2 made in the 19th century. (It is curious that there seems tu have been many more such measurements in the last 30 years of the 19th century thon in the first 30 years of the 20th century.] Most of these were made in western Europe As was mentioned above, Callendar [1958] examined many of these and selected a few he believed to have long enough records with good analytical techniques and relatively uninfluenced by local contamination from cities to arrive at his estimate of 290 ppmv as the appropriate "pre-industrial" value, nominally about 1880-1890.

Two sources of possible error in the early measurements must be distinguished: errors inherent in the chemical techniques and sam-pling errors. In principle, the chemical tech-niques used were capable of giving values within 1-2% (3-6 ppmv) of the true value, but the precision of the measurements was rarely as high as can now be achieved. The very large number of samples needed to obtain reliable mean values and to assess the precision were almost never made, and there were almust no calibrations against known standards. Short of reconstructing the actual apparatus used, there is almost no way to valuate the actual measurement accuracy

and precision of these early measurements. We now know a great deal more than did the early investigators about the character of background CO2 concentrations. Background concentrations show little diurnal variation and a clear annual cycle with a maximum in the late spring and minimum in late summer or early fall. There is a small latitude gradiem in the yearly mean value but a more pronounced latitude gradient in the peak-totrough annual cycle with a peak-to-trough range of about 15 ppmv at the latitude of northwest Europe, diminishing toward the equator. In the southern hemisphere there is only a very small annual cycle. Year-to-year changes are now about 1-2 ppmv, probably within the precision of the older measurement techniques. These characteristics can be expected to be valid in the 19th century and

so used to evaluate some of the early records. 80th diurnal and annual cycles in atmospheric stability can produce a COs record biased toward higher values if measurements are made near vegetation. A 24-hour mean value would likely show values ton high conpared to background, because the daytime photosynthesis drawn flown occurs when the up at night due to respiration occurs with a

pourly mixed utmasphere. The same organient ran he applied to the annual cycle. The atmosphere in morthwest Europe is stable in winter when photosynthesis is at a minimum, whereas it is less stable in summer. Arcompanying this are the likely greater emissions from fuel in winter. Thus, it is not surprising that many old records (and some modern ones in Europe) show a witter rather than a spring maximum. This bias, together with the possibility of a regional contamination locause of fuel use, suggests the early data from Europe are likely higher than the real background.

Some unrighing data were taken from remore lucations in the tropics and the southern hemisphere by Aluniz and Aubin [1886]. These data-taken nll together-suggest a mean value of about 270 ppmv for the southern hemisphere. Because they were taken ot . remote sites with little aunual or diurnal variation by rareful scientists, one is tempted to accept them as being background data. But there are problems. The data show a much arger latitude gradient than is found today (the values decreased from the tropics to 30°. outh by 20-30 ppniv). This suggests prob-

S 280 500 1000 1500 OATE LYEARS ADJ Fig. 1. Estimates of past atmospheric carbon dioxide concentrations. A, measurements

from Mauna Loa Observatory [Keeling et al., 1982]. These data are within 1% of the globa tropospheric mean. B, based on unpublished analyses of archived solar spectra. C, decadal average data from Montsouris Observatory, Paris, as recently presented by Stanhill [1982]. D, model calculation for comparison, extrapolating from "A" assuming fussil fuel combustion to be the only source of CO₂. E, analysis of subsurface ocean waters giving pCO₂ at the time when the waters were in contact with the atmosphere, approximately 150 years ago [Brewer, 1978]. The solid bar represents random uncertainties, and the dashed arrow indicates a possible underestimate of up to 25 ppnty. F, air sampled at Cape Horn [Muniz and Anbin, 1886]. The standard deviation bar for 39 samples indicates that the variability is uncharacteristically high for southern hemisphere background air. G, typical of model calculations assuming 150 Gt of non-fossil carbon released at about 1900 (see, for example, Euling and Pearman [1982], Enting et al. [1983], Pearman et al. [1983]. H. estimate obtained using models to interpret ¹⁸C/¹²C content in tree rings [Peng et al., 1983]. 1, CO2 concentrations in air bubbles trapped in glacial ice, based on results from French and Swiss laboratories [see laruola et al., 1983], believed to be representative of atmospheric concentrations at the time of trapping. Average for period A.D. 1 to 1850. J. As "H" but with rings from A.D. 285-1850 with data normalized by annual ring growth. Different trees and a different model were used than "H" [Stuiver et al., 1984]. Early observations selected by Callendar [1958] as being representative of background air. Note Callendar chose to exclude the Montsouris "C" and Cape Horn data "F" from his analysis.

lems with sampling or analytical techniques, or possibly problems maintaining sample integrity since CO2 was trapped in sealed containers and returned to France for subse-

Analysis of Spectroscopic Data

As simlight passes through the atmosphere, the molecules in the air absorb radiation an specific wave lengths. The amount of absorption is a function of the molecule properties and abundance. Thus it should be possible to determine the concemration of CO2 by examining the absorption lines in the solar spectra. The analysis of archived solar spectra offers a way to estimate atmospheric CO2 concentration prior to the Maura Loa record. The spectrum of the earth's atmosphere has been recorded with regularity for almost 100 years. The most important of the spectroscopic data were taken as part of the Smithsonian Solar Constant program, which ran from approximately 1902 until 1956. In this program the spectroscopic data were collected for the express purpose of measuring the transparency of the atmosphere. The spectra were collected almost daily at several sites around the world. The bulk of the data that still exists fcom this program was taken at the Table Mountain Station (altitude 2286 m) in California from 1927 to the late 1950's. The technique for analyzing these spectra is still being

To establish that the spectroscopic tlata will provide an extension of the current recurd of atmospheric CO2 concentrations, the relationship between vertically integrated column densities of Co2 and surface measurements must be determined. Another issue is whether the old spectroscopic data base can be analyzed with sufficient precision (better than 5% or 15 ppinv) in order to make a useful contri-

The attempt to establish the relationship between the integrated column and surface meaurements is based on 4 years of observations taken at the Kitt Peak National Observatory on an almost monthly basis, weather permitting. A preliminary analysis of these data oxiniately 1%) and reasonable accuracy, with an average concentration of 340 + 10 ppmv for the period 1978-1981. This is compatible to the average concentration of 337 ppmv observed at Manna Loa during this same period. The dats also appear to contain a signal due to the annual variation of CO2 concentration. In support of this effort, flask samples of air for separate analysis by National Oceanic and Atnospheric Administration (NOAA) have been collected in conjunction with the spectroscopic program.

A preliminary analysis of the historical Smithsonian data gave encouraging results but was clearly subject to systematic errors. The source of these errors is almost endrely the incomplete knowledge of the spectrobolo graphic equipment used in the observations.

The two dominant sources of systematic error have been identified as scattered light in the instrument and poor knowledge of how the

instrument was acqually operated.

The most intecoally consistent analysis thus far gave values of 312 and 316 ppm for 1985. and 1941, respectively. These values are higher than would be expected from the post-1957 record, but the expected values are within the 90% confidence interval of these

measurements which is approximately +15 ppinv. (Since the incetting, an improved technique [Stokes and Barnard, 1984] has made it possible to separate the errors into random and systematic companents. For 1941 the figure is now 311 + 11 ppmv. The 11 ppmv an certainty is composed approximately of a sys-tematic term of 2 ppmy and a random term of 9 ppmy.) While these remain provisional results, the analysis of this subset of the Smithsonian data suggests that the technique offers considerable promise, and the meeting participants felt it desirable to attempt to anaze all available spectrograms.

Past Atmospheric CO: Record From

The process of transforming snow to ice on daciers and ice sheets traps air within the ice. Below a certain depth the trapped air becomes isolated from the atmosphere and so a sample of "old" air can be obtained whose CO2 content should under certain conditions rellect the atmospheric composition at the time of ice formation.

Great care is required to extract the air from these buildes in ice cores and tu measure their CO2 content. In addition, there are several problems in interpreting the resulting data. The CO2 represent within of the euclosed air may diller from the original atmosphere because of various physical and chemical pro-cessors. For example, if the surrounding ice has been subjected to melting and refreezing during its lifetime, spurious results can be ob tained because of the high solubility of Cor in water. The core drilling process itself may introduce problems particularly if the core has fractured. Some of these problems can be minimized by selecting unfractured cores from very cold sites with no summer melting-When selected in this way, the CO2 concentration in the bubbles should not differ from that in the atmosphere by more than +15

Another problem arises in assigning a date to the sample. The trapping of the sir occurs during the time interval corresponding to the time required for the firm to become ice. This typically takes 100-1000 ye snow accumulation rate and temperature Neighboring bubbles may have different age depending on when a particular bubble was occluded. Although the age of the surround ing ice can generally be determined, the bubble's age can differ by 100-1000 years from this age. The time resolution of a sample determined by the duration of the gas endo sure process, and there remains some cont versy about the assignment of a specific time Interval for this duration.

Despite these uncertainties, which may be reduced in the future, bubbles in old ice are probably the most reliable samples of old atmospheric air. An encouraging result came from an interlaboratory comparison between the groups at Bern and Grenoble [Barnola s] ol., 1983]. The results from the same ice cores were within the experimental error linit of 3%. Results obtained in the two fabora tories gave mean atmospheric concentrations between 258 and 270 ppmy for the time interval between 500 B.G. and A.D. 1850, Very recent measurements with a new extraction technique at Bern, however, suggest these technique at Bern, however, suggest these values may be too low by about 10-20 ppm values may be too low by about 10-20 ppm Further investigation is needed. In addition preliminary results suggest that natural fund

tuztions on the order of 10 ppmv could have occurred during the A.D. 1500-1850 period [Raynaud and Barnola, 1984].

CO. Values Derived From 13C and 14C Records in Trees

The history of the 15C/12C and 15C/12C isotope ratios of armospheric CO2 provides additional information on past changes in atmospheric CO2 content. Different information is derived from the two isotopes. Whereas the stable 19C and 12C are of primordial origin, the natural 14C currently encountered in our carbon reservoirs is produced by cosmic radiation in the upper atmosphere. The half-line of LC is short enough (5600 years) so that nn LC is found in fossil fuels [q] The LC/LC history of atmospheric carbon reflects changes in the size of, and exchange rate among, the various terresterial carbon reser-

voirs and the variable 14C production rate in

With the current available knowledge of solar modulation and earth geomagnetic change it is possible to calculate, with the aid of a carbon reservoir model, the natural atmospheric 14C levels of the 19th and 20th centuries. The deviation between these calculated 14C concempations and 14C measurements in tree rings is attributed to the lowering of 14C concentrations by 14C-free fossil fuel Go2 release. This 14C lowering can be followed up to 1952 when nuclear bomb testing added large quantities of 14C to the atmo-

The calculated amount of 14C-free fossil fuel CO2 needed to explain the 14C record agrees with the CO2 emissions derived from fuel production data within 10%. This agreement points toward the reliability of the carbon reservoir model used.

In assimilating carbon from the atmosphere, photosynthesis discriminates against the heavier carbon isotope ¹⁵C. The ¹⁵C/¹²C ratio in organic matter is about 1.8% lower than that in the atmosphere. Fossil fuels, being formed from organic matter, have a simi lar 13C deficiency. Thus changes in the size of the biosphere should introduce changes in atmospheric 13C/12C ratios, and so a history of these changes should give a record of COz added to or subtracted from the atmosphere because of changes in the size of the bio-

sphere as well as by tossil fuel combustion. The 13C/12C records of tree rings are used to derive the atmospheric 13C/12C signal. The tree isotope ratio not only reflects the atmospheric ratio but also a variable fractionation against the heavier 13(: isotope charing photo synthesis. For an accurate interpretation of the 13C/12C record of trees, the mechanism(s) that induce variable fractionation have to be understood. The rate of assimilation, leaf conductance and atmospheric CO2 pressure affect the ¹³C/¹²C ratios in plants as well as the number of leaves. Thus, it is not surprising that a multitude of 19C/2C trends has

been found in trees from the past centuries. 12C/12C records from trees from Pacific coastal sites (53°S 10 58°N latitude) [Striver et al., 1983], yield model calculated pre-industrial atmospheric CO2 levels averaging 276 ppmv for the A.D. 234-1850 interval. Appreciable interriccadal variability exists, lurwever, running from as low as 230 ppmv to as high as 310 ppurv. A substantial portion of this variability probably results from tree-induced variations in the 13C/12C record despite attempts to eliminate some of them. 14C/12C records from mainly European and eastern U.S. sites show a larger biospheric signal, and the model calculations of this signal yield an atmospheric CO2 level of 242 ppmv around A.D. 1800 [Peng et al., 1983]. (A recent reevaluation by the same authors [Peug et al., 1984) yielded a value of about 266 ppmv.) The same 13C/12C record, when used in the Stuiver et al. model, yielded a pre-industrial value of 230 ppmv around A.D. 1800. Thus, model differences can lead to differences of the order of 10 ppmy in calculated pre-indus-

Ocean Chemistry Evidence for Pre-Industrial CO2 Concentrations

There have been recent attempts to detect the ocean CO2 increase by examining conleinporary ocean CO2 measurements. One scheme used by Brewer [1978] is to calculate the partial pressure of CO2 (pCO2) of a deep ocean water sample ofter correction for the rather large changes due to respiration and carbonate dissolution that have occurred during the waters' history. The result is an esdmate of the pCOs aclieved by a particular water sample when it was last at the surface. The requirements for the calculation are: (1) arcurate roeasurements of alkalinity and total CO2 (the total amounts of CO2 in all its inorganic chemical forms); (2) the ability to calculate the extent of carbonate dissolution; and (3) accurate knowledge of the respiration coefficient, which is the ratio of the change in total CO2 to the change in 02 (This is conventionally calculated from the relative abundance of carbon, nitrogen, phosphorus, and oxygen (the Redfield ratios) and is taken to be 0.768.).

The most accurate and detailed data set available comes from the transient tracers in the Ocean North Atlantic Experiment. Deep Waters formed mainly at the surface in high latitudes penetrate into the abyss. The age of these waters can be assigned quite well, both from their radiocarbon content and from the penetration of bomb-produced radionuclides.

The CO2 system properties have also been measured in these waters. Applying the calculation scheme of Brewer [1978], modified to correct for die effects of phosphate and silicate, one can derive an "initial pCO2" for these waters. A value of 265 ppmv is calculated for water about 150 years old. How arenrate is this result, and what does it mean?

The nutrient, salinity, and temperature measurements are highly accurate. The alkalinity data have been subjected to independent checks and appear to be accurate to 0.15%. The total CO2 data used here have been determined by potentiometric titration and should be treated with caution. Independent checks against the highly accurate gasometric procedure of Keeling show a complex small error in the titration data. The source of this error is not yet clear. Applying the Keeling total CO2 correction would result in initial pCO2 values in the deep waters as low as 258 ppmv.

There are other sources of error. Furthermore, the descending surface waters, formed in wintertime, may not be exactly in O2 saturation equilibrium with the atmosphere, as required by the calculation. The error from this source is, however, likely to be small. The largest question is how to interpret

this number North Atlantic waters are cooled faster

than they can achieve CO2 equilibrium with the atmospheric and may sink before achieving equilibrium. Biological activity further lowers pCOz. Thus marked, COz disequilibria are found in northern surface waters. It is not known what the pCO2 "label" of the deep waters is at the time of their formation since both surface and intermediate waters, which liave equilibriated with the atmosphere at other latitudes, are likely entrained in a complex and unobservable process. The likeliood is that newly formed North Atlantic deep waters descend with a pCO2 value less n satuaration equilibrium.

The estimate of 258 ppmv CO2 for waters of 150 (+50) years or so age in the deep North Atlantic is thus a lower limit for the at

It would, however, he hard to reconcile a value a great ileal higher than this with the occanic data. Values of 290 ppmy, for instance, would present considerable difficul-

CO2 Variations During the last 50,000

Ice cores can be used to extend the CO2 record back over the last 50,000 years. The main features are low CO2 values tabout 200 ppmv) iluring the last glacial maximum, around 18,000 BP, and a rapid increase to values which generally remained within the interval 260 to 300 ppmv during the Holo-

cene [Berner et al., 1980; Delmas et al., 1980]. One of the most intriguing pieces of infor mation was the recent measurements indicating that during the last glaciation there were several occasions when the atmospheric CO2 content changed between about 180 and 250 ppinv [Stauffer et al, 1984]. The time needed to shift from one value to the other seems to be of the order of only a few centories. This fact should be considered, not only in atempts to understand the basic regulation nieclianism for the atmospheric CO2 content but also in the assessments of climate implications of the current period of observed CO2

Discussion

Each of the techniques for estimating the older CO2 values has shortcomings. In some cases the estimates could be improved by further work and likely will be. The group felt that further study of the older chemical records since about 1880 in the light of our knowledge of the characteristics of background data could produce better estimates or at least put more stringent limits on the values. Continued work on the spectroscopic data was encouraged with consideration being given to determining the ratio CO2/O2 from the plates to help eliminate some of the errors. Spectroscopic data could be particularly valuable in filling in the period between 1900 and 1958.

The ice core analysis currently seems the best method for determining the pre-1900 values and is the only method available for obtaining values back many thousands of years. The continued study of these cores was encouraged with some thought given to the improvement of the experimental accuracy, to orr-site analysis to quantify the gas trap-perg process and to eliminate contamination

The carbon isotope data from tree rings re main tantalizing because they offer the possibility of determining the biospheric contribution to atmospheric COs for mony centuries or millenia in the past. Efforts should be made to reconcile the differences among the various attempts to use the ¹⁸C/¹⁸C rados. Better understanding of physiological effects in isotope fractionation or methods of eliminating their effects in the analyses are need-

At present the results of CO2 reconstructipn from ocean chemical data are ambiguous, but the technique deserves continued effort. A suggestion to examine isolated seas,

such as the Red Sea, might be fruitful as they have a single ileep-water formation area and

fewer problems with disequilibri Figure I represents a summation of the results considered at the meeting. Despite questions and uncertainties associated with each estimate, the group was impressed with the convergence of these techniques on a value (or values) singilicantly less than 290 ppmv. It was a general conclusion that the mid 19th century values were not very onlikely to have been less than 250 ppmy or much greater than 200 ppniv. Somewhat subjectively the group felt values between 260 ppmv and 280 ppmy were the most likely prevailing CO2

ncentrations during the mid 19th century. In addition to lower values in the last century, several other cunclusions were drawn from our deliherations. It is probably misleading to refer to a single pre-industrial value in the last century. The group could not plot a curve of most likely rate of change but it seems quite possible CO2 was increasing with time in the 1800's. Reaching back further in time there was evidence for natural fluctuations at least of order of 10 ppmv in the last few centuries. On the much larger time scale of ice ages, fluctuations of perhaps 100 ppmv are likely. The causes for these fluctuations remain abscure but changes in ocean circulation and binlogy are logical can-

Implications

The meeting participants discussed some of the implications of these findings. First, of course, is the conclusion that 19th century concentrations below 200 ppiny imply that non-fossil fuel source must have been in elfect. A value near 270 ppmv would imply this source was as large as the fossil fuel source between 1860 and 1960. This source is most likely the terrestrial hiosphere, a contention supported by the isotone records.

As mentioned above, a back extrapolation of the Manna Loa record, assuming a constant airborne fraction of the Jossil CO2 input, yields a calculated pre-industrial value of about 294 ppmy. A more uphisticated back extrapidation uses carbon cycle models, calibrated by means of the observed recamic distribution of either natural or bomb produced ¹⁴C. On the basis of the known bissil Incl. CO2 production rates, these models generally predict an atmospheric increase slightly largor than the observed trend from 1958 onward. Therefore, a usually additional sink typically of about 1965 of the fossil fuel production and in addition to the oceanic CO2 untake, has to be assumed for these carbon ev-

cle models to reproduce the observed trend. With one such could a lower 19th century value (e.g., 265 ppmy in 1820) implies a nonfossil source large in the 19th century and declining from 1900 to near zero that positive) about 1970. In this case the model is thus able to reproduce the post-1958 record without recourse to a biospheric sink. This example suggests that lower initial CO2 values may help solve a problem of current carbon

cycle models. The possible occurrence of significant fluctuations in the past gives additional problems for carbon cycle modeling, however. If forward extrapolation with assumed fossil fuel sources is used to predict future atmospheric concentrations these other, as yet unidentified, causes of fluctuation will need to be un-

There are implications for the determina tion of the response of the climate to in-creased CO₂. It was noted that if the concentration in 1880 was lower than previously assumed, then there has been a larger effect of COs on the climate of the last 100 years than if the concentration had been greater. A simplified model was shown where the equilibrium response to a doubled CO2 concentration was taken to be 3.2°C and an effective ocean heat capacity calibrated with bomb-produced 14C data was included. For an initial concentration of 297 ppmy the model [Siegenthaler and Oesthger, 1983] gave an 0.26°C warming by 1980 whereas with a 265 ppm initial cor centration, the model gave a warming of 0.62°C. Furthermore, the time change of temperatures with the lower initial concentra tion appeared to lit the porthero hem surface temperature thato of Janes et al. [1982] better than that starting with 297 ppmv. Nev ertheless, the temperature record is not fully explained by CO2 only forcing and indicotes that global temperatures have been influenced by additional factors. These factors will have to be better understood before the influence of CO2 can be extracted from the

temperature records.

There is another implication of relatively low 19th century CO2 concentrations. As pointed out in a recent review of the CO2 nestion [Carbon Dioxide Assessment Committe 1983] an ocean response time of 15 years and a warning of 0.5°C up to 1980 can be comnatible with an conillbrium temperature change of 4.5°C for doubled CO2 concentrations if the COs concentration was about 300 ppmy in 1850. If the 1850 concentration was well below 300 ppmv, and other foreing fac-tors did not intervene, the equilibrium temperature change must be below S°C (as low as 1.50 if the 1830 concentration was 250 ppmv) to avoid inconsistency with the temperature record. It is that temperature record and the Carbon Dioxide Assessment Committee esti-

mate that the 19th century CO2 concentra-

tions were lower than 290 ppmv led them to conclude that the equilibrium climate response to doubled CO2 was more likely in the lower half (1.5°-3.0°) of the range suggested

by the climate models. The implications for carbon cycle studies and for validating climate models point up the desirability of establishing the time record of atmospheric CO2 concentration much better than we have been able to do here.

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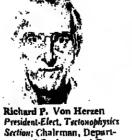


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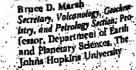
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Aeronomy

DAGO LYraveling ionospheric disturbances)
THE SHIGHT DEPEMBENCY OF TID AND GRAVITY WAY! YARAMETERD
S.L. Tadd. N.G. Morgan [Hadiophysias inhoratory, Theyse
sitheol of Engineering, Datamosth College, Hanover, Mov
Empshire, 07185), K.A. Salisad
The height dependence of ampittude and both
borisontal and vertical stace speeds, Tor individual
spactral comments of F-region TiD's, are obtained for
the lirst rime by means of a three-station network of
rapid-run ionosandes. The corresponding caussaive
gravity wave parameters are derived using a previously
developed inversion technique, which is extended by
incorporating the offsets of dissipation and ion
dilitation. Resenceable agreement is achieved between
the beight variation of the rasi part of she versical
acaptement of the gravity wave phase propogation vestor,
by obtained from the inversion processe, and aniusions
of a dissipative disparsion relation for F as
disipative of the vertical componees of the gamulay
distrant heights. Height dependent values of the
imaginary part of the vertical componees of the gamulay
for the inversion, are computed from the dissipative
dispatation valuation. Values of k, obasined from
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and small dissipation. Values of k, obasined from
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and small dissipation, yield erroneous results for the
verse considered, segmenting pravious sheoratical
results that here employed these sessuaptions. [Ornvivy
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J. Geophys. Ran., A, Paper 4A0B01

Electromagnetics

B730 Electromagnetic Theory
The EFFECTIVE CROSS-SECTION METHOD FOR DIRECTRIC
MANAGUIDES IN 604 ON A BURSTRATE
Missard F. Education and Computer Engineering,
University of Colorado, Bouldar, Colorado, 801091.
It has previously beam shown that the propagation
constants of step-index distantic vaveguides of
achisary cross-section and small index contrast one
be computed accurately using a related setallic vaveguide of a certain "effortive gross-section." In this
paper as tread the method to treat waveguides whose
clading is inhomogeneous, and whoma tefractive index
is not necessatily close to that of the core (quiding)
region. The results are applied to dislactic waveregion. The superesions obtained are again quite
simple and require knowledge only of the TW-mode eighnvalues of a similarly-shaped petallic waveguides.
Rad. Sci., Paper 450822

OTHS ADDRESS OF VENTICAL ELECTRIC AND MAGNETIC DIVIDE AROVE A DISHIPATIVE ORDERD A. Albert A. V. Edndall (Department of EE, Selinki University of Technology, Otsheari 5 A Calib, Repoo, Finland; Cali magnetic formulas for a small horizontal vice loop and for a small vertical dipole shows the surface are delived using the exact image triangles. The resulting integrals appear extressly soot results with the simplest newsrican and give soot results with the simplest newsrican and give lines. And, Sci., Paper 450840

Exploration Geophysics

he made. Overall results suggest that radio-Frequency Overall results suggest that radio-Frequency geotomography can be a useful tool for mapping in-situ uniature toncentrations and sampareture ironts in an operating in-situ oil-shale retort. OKOWERSICS, VOL. 49, NO. D

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Guologiques et Minieres, av. de Contyr, Orionas-La-Soutte
& B 5009, Oriesas (3060 Cases, Francol V. Menichati
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is well known, is order to remove ambiguity, some authors
have accept adjustions minimizing a familiand describing
geometrical or physical properties. Later and fabilis
11943), in papertralar, developed a mathod explaining the
observed appeals by spatializes of minimum volume. In this
perhod the domain where geometrics are searched in

alsorighms which read digitally recorded input data and interpret them automatically in terms of a simple electrical section that is defined by a single conductive layer whose thickness, conductivity, and subsuriate depth are determined from the data. But more that to the age to the total partners, horizontally stratified earth condet; it is only applicable in regions where the surficial incertions are didly dispens and the conductive layer is covered by, and rests on, highly constituted by the layer accounted by, and rests on, highly constituted by three limit evapoles. At the first limit turns are allowed in the conductive layer is covered by, and rests on, highly constituted by three limit evapoles. At the first limit true was allowed in the limit of the interlace between control and allowed in the strong three properties. It is allowed in the strong of the interlace between the action of a subsorial conductive light the first conductive light. The first leading to the first conductive light the first completive walley little with conductive light, the first completive walley little with conductive light.

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Ectimotion of Some Characterictics of Breszo Structure

Exagin B. A., Troinikny V. S. Specification of the Radiative Model of the Strotus

Zage E. P., Cholkovskoya L. I. Metrix Coefficient of Radiotion Brightness Reflocted by Somi-Infinite Absorbing Modelum with Strong Anisntropic Scattering

Function

Dolin L. S. Gharecteristics of a Confined Light Boem in on Absorbing Medium

with o Nerrow Scottering Phase Function

Zakharov V. E., Zaslavsky M. M. The Dependence of Wave Parameters on Wind

Velocity, Its Duretion and Fetch in o Week Turbulence Theory of Wind

Weves

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on the Stability of Jet in a Two-Layor Flow

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Gurvich A. S., Kon V., Popov L. I., Ryuciln Y. V., Savobeoko S. A., Sokofovsky S. V.
The Messurements of Atmospheric Refroction nn the «Solyut-8» Orbital Station and the Recovery of Temperature Profile

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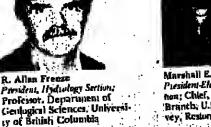
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Glasse Weithelmanth. Recommendation of National Profit of National Science (2013) 401-401-401

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R. Allan Freeze President, Hidsology Section,



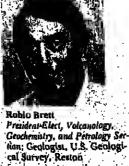














Chapman Conference on Vertical Crustal Motion: Measurement and Modeling

A Chapman Conference on Vertical Crustal Motion: Measurement and Modeling will be held October 22-26, 1984, in Harpers Ferry, West Virginia.

Convenor: William E. Strange

This conference will bring together scientists who measure vertical crustal motions and those who analyze and model these motions with the primary objective of obtaining close interaction between the two groups. Emphasis will be on vertical crustal movement in North America. Questions to be addressed will be (1) what are the accuracies and error sources associated with each dain type? (2) What is the extent of the current data base? (3) How accurately do we know vertical crustal motions in North America? (4) What are realistic expectations of contributions from space systems and other new technologies in the next decade? (5) What is the current status of modeling vertical crustal motions? (6) Flow important is vertical motion information to understanding and modeling earth dynamics? (7) What are the measurement requirements to support modeling and analysis in terms of temporal and spatial density and accuracy? (8) What are the most critical deficiencies of vertical motion data relative to modeling and analysis?

There will be invited and contributed presentations. The Call for Papers was published in the March 20, 1984, issue of Eos. Abstraci deadline is August 1, 1984. Abstracts should be submitted to the American Geophysical

For information on the required abstract formal or further meeting logistice, contact:

> AGU Meeting Department 2000 Fiorida Avenue, N.W. Washington, DC 20009 (202) 462-6903

For program information contact: Dr. W. E. Strange NOAA/NOS/CNGS/NGS/N/CG11 6001 Executive Blvd. Rockville, MD 20852

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includes represents live examples on standard data serve
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such as 2-D delts functions, boxcar avonts of functions, delta such as a 2-D delts functions, boxcar avonts of functions
substitute of the Redon transform.

OPOPHYSICS, VOL. 49, NO. 8

OPOPHYSICS,

propagation especially onen related to surfiquable.)

measurements.

But VBT and sonic log velocities for traveltiment are
often found fo disagree. Secant field evidence of these
offferences suggested that the VBP traveltimes are delayed
with respect for the intergrated sonic times, especially
in the deep section 121000 it.), by about 1.0 may/1000 it.
on the average. The VBF has oumerous applications in
exploration grophysirs, such as calibrating the sonic
log. It is thus important to understand why the two
assurements differ.

2560 line Vertallone (Severole)

exploration grophysics, such as calibrating the sould log. It is thus important to understed why the variety department differ.

Oliforences in the geometries, source irequencies, and instrumental errors of the two surveys are reviewed. Sore instrumental errors of the two surveys are reviewed. Sore detailed scalesis of sound two prepagation in the CSP shows that short-path multiples and velocity dispersion can have a signifit and delaying affect on the solestic revestitions, bee-disamsonal, wide-band CRF synthetic selmograms are generated in the Irequency domain to study these effects oliferont parameters thandwith, signal-to-noise, layer thickness, multiples, attaination, diappratoni are varied in the synthetic salmograms. A comparative display of synthetic VSP treveltions induced the front than and the comparative display of synthetic view the effects of those parameters on the available traces. Freedomable werlarions in noise, layer thickness, henduldth, and picking acthod have a small effect on traveltimes. It is dead to view the effects of the second of the present instead data from the Anadarho basis of wells; and as Sast Texas well are asselined with the same technique. Front the conditing and field examples, it is found fast short-path multiples tan cause a selanic pulse delay of up to 1.0 ariloob it with respect to the integrated sonic loa in highly eveiledily straified sections. Yelocity dispersion associated with attenuation can have a larger reversal propagation of facts can explain the observed discrepancy between VSF and integrated sonic time in the does section.

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modeling and prediction of frecturing

Timashovn A. N. On regularities to the variations of boundary velocities within the
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Yopinetyovo A. M., Petersen N. V. Seismic modeling used for metching the deta of
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Burlaiskoyo S. P. Dipole properties of the encient geomegnetic field.

Pechoroky D. M., Didenko A. N., Kurenkov S. A. Geologic and petromegoetic studes of the Mugodjar complex of parallel dykes.

Monokhov F. I., Khontayev A. M., Kechaykina V.S., Shielikin A.A. Comparing the

olon tosts Blokh Yu. I. Magnetic field calculation of a three — dimensional teotropic body in-

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Rizatchonko O. Yu., Neveky M. V., Nikolayov A. V., Nekrasov G. A. A case study

responses of groundweter table end discharge to preperction processes of an earthquoke

Mukhomedov Y. A. Acoustic forerunners and fracturing kinetics

Goncharov A. L. Kuznetsov Y. M., Livshile L. D., Somerchen A. A. The load redistribution on the supporting surface of o specimen in lorge-acele axial compression.

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codskoya S. Yu., Valeyev K. A. On the origin of carbonalities from the Gulling emblinative V. S., Shcherbokov V. P., Vinogradov, Yu., K. Induced entsotropy effects
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the North March Minister British of Lawrence Berraley (California, Serialey, California, Serialey, California, Serialey, California, Serialey, California, Serialey, California, Serialey, Calculations to investigate whe effect of path torsocity sed connectivity on floid flow rate through a single rough fracture were carried out. The flow paths are represented by electrical resilience pleeded on a reco-discussional grid, the resistances vary as the towarts of the iresture specture tweet. The sleetric cuttent through the cirruit bears some-to-one correspondence to the fluid flow rate. Both Irecture apertures derived from measurements sed loos hypotherical subject lumctions were used in a parameter study to investigate the dependents of Cortwority on fracture roughness that details affect of nortwority on fracture roughness where are in the separture discribution, the larger (a che affect of nortwority. When the fraction of locatest aces between the fracture surfaces rises above 10%, the specture discribusions are invacibly farge at Easil spectures the fracture appresent flow rate from the value predicted by the parallel place representation of a fracture by three or more orders of magnitude the impact of rose aresults on the californians and flow path tortworlty!

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3130 Groundwater INTERPRETATION OF BOWNHOLE DATA AND REVELOPHEST OF A CONCEPTUAL MODEL FOR THE RESORDS CREEK AREA OF THE

115b Preripiration [Hydrology]
A SPECTRAL THUORY OF RAIMPALL INTENSITY AT THE MESO-0
STALE
E. Mayairo, V. A. Cupes [Department of Civil Engineering,
Gelversity of Mississippi, University, Mississippi 386771,
L. Rodriguer-liumbs

The available empirical descriptions of estratopical captionic stores are employed to forevalue a physically realistic atochestic representation of the ground level rainfall intensity field in space and fina. The siophastic representation is based on three component stochastic point processes which passes the general features of the unbodding of raincells within soil mesostate areas within large mesoscale areas within apoptir storms. Certain states identified, and assumptions on functional forms which qualitatively reflect the physical features, local to a closed form expression for the romatiant function, i.e., the real space-time spectrum, of the rainfall intensity field. The theoretical spectrum explaines the expirited spectrum features the criminal population of the apportance in this counstion is an explanation of the ampiritial observation that the Taylorian propagation of the first scale struture, via a transferrance of time to speec through the store velocity, holds only for a small time lag and not throughout. The results here indicate the plant of this lag in tree of the cheacteristic areas a resultance of the cheacteristic areas a resultance of the cheacteristic areas an excellent with call durations, callular birthrates and velocities, atc. [Besescale.]

3160 Runoff and Stream[low

Bouss, Station Road, Cambridge, CB1 185, URI and S. M. Shaw
The discharge measurements of the Rivet Chari at
M'Djemina and lake levels at Bot have been used to
derive models to Lorecast sinknum water fevels of Lake
Chad. Pirst. an auconegressive model is obtained to
calculate the change in minimum lake level from one
year to the nest, given the Chart discharge and the
minimum lake depth in the pravious year. a more
rigorous analysis of the date produces forecasting
models on a probabilistic basis to measure the risk in
selecting various abstraction levels of water. The
probabilistic models assume lef the date are purely
random, the the discharge meries contains cyclical as
well as steahestic components. Sividing the range of
lake levels into 12 designated status, probability
astrices are derived for state transitions for a single
yeas chead and for n-mings shead. The expected success
of n-step shead forecasts is obtained. Glagrams
showing the probability of svessdance of minimum lake
level stream using the random and nixed process models
are presented. Lishe Chad, Charl stver, water favels,
probabilistic models.

Water Resour. Res., Paper 490172

Journal of Geophysical Rasearch

Volume 89 Number D4 June 30, 1984

NiMBUS 7 Scientiffc Results

Vater Rescur. Res., Paper 4VG828

Albert J. Fletg and Rulph J. Userone
The NIMBUS 7 CZCS Experiment in the Hengueta Current Region off Southern Africa. February 1980, 2.
Interpretation of Imagery and Occusiographic Implications (Paper 31154).

L. J. Shannon, P. Schlatenhardt, and S. A. Hostert
CZCS Data Analysis in Tarbid Constal Water (Paper 31169).

M. Vadher and B. Sturm
Reflectance Characterbures of Uniform Earth and Cloud Surfaces Derived From Numbur-T ERH (Paper 310625).

The NIMBUS 7 ERB Experiment Team

R. M. Nagatani and A. J. Miller 5191

11 State Product for 1979 Profit the HIMBUS 7 SBOV Instrument I rapes 20 and 305 nm 1 Paper 4D0319)

12 Intercomparison of HIMBUS 7 Solar Backscattered Ultraviolet Ozone Profits With Rocket, Balloon, and Umkeht Profits 1 Paper 3C1227)

12 Intercomparison of HIMBUS 7 Solar Backscattered Ultraviolet Ozone Profits With Rocket, Balloon, and Umkeht Profits 1 Paper 3C1227)

12 Intercomparison of the NIMBUS 7 SOUV/TOMS Total Ocone Data Scis With Dobson and Mills 1 Paper 3C1681

13 Paper 3C1681

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17 Paper 4D03171

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15 Some Aspects of the Design and Behavior of the Stratospheric ond Measurements (Paper 3D1685)

16 C. D. Rodgers, R. L. Jones, and J. J. Barnen C. D. Rodgers, R. L. Jones, and J. J. Wale and G. O. Peskert M. J. Wale and G.

Evaluation of HIMBUS 7 TKIR/CLE and Air Force Three-Dimensional Nephanolysia Bellmates of Cloud
August (Description 1) Larry L. Stone

Mikhaylov V. O. A unthematical motiol for the evolution of structures produced by the vertical movements

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3190 Isstruments and Techniques Misture Claiributions)
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KITTURE OFFSTEPFICES
K.M. Leythums (9538 Ath Ave. 8.5., Deattis, WA 981(5))
Raximum lihefihood satisates for the pursuetars of a
slature of two normal distributions are presented in
terms of an expectation-maximisation sign(fibs. Small
sample properties of both parameter and quantils satimates are explored saing Monke Carlo simulation. Although parameters estimated from unclassified data are
inscensed, quantiles estimated from unclassified data
are found to be only slightly less assurants than
quantiles assizated from obsessions. dues of the initial storage (the solection of these va-lues is guided by a one-discussional searching acthod. These dilicient operating rules can be interpreted in terms of storage altoration access which are not predo-termined but degend upon the forecast of the inflows. Moreover, when the reasonable for not up full or too Vater Raenat, Res., 496154

> sale approach is quite powarfull in pointing out the possibility of improving the performance of a reservoir already in operation. treservoir management, optimal

The Earth Radiation Oudget Derived From the NIMBUS 7 ERB Esperiment 1Paper 3C1821

Highert dis about 2, Richard J. Tiglic, and the SIMBUS 7 ERB Esperiment 1 on A Chibration Adjustment Technique Combining ERB Parameters From thifferent Remote Serving Platforms into a Long-Term Data Set. 1Paper 4D02021

Philip C. Andunny and Highert Incobooks The Earth Radiation Budget (ERB) Experiment: An Overview (Paper 30 1848)

Herbert Jacobowts, Hand V. Soule, H. Lee Kyls, Frederick B. House, and The MIMBUS 2 ERB Experiment Town

Degradation Asymmetries and Recovery of the HIMBUS 7 Earth Radiotion Budget Shortwaye
Radiometer 1Paper 1018451

NIMBUS-Earth Radiation Oudget Sensor Characterization for Improved Outo Reduction Endelly 1Paper 4000401

R. Marchhoff, A. Jalink, J. Hickey, and J. Swedberg
Redicated the Fight Calibration Adjustment of the NIMRUS 6 and 7 Farth Radiotion Budget Wide Field of View
Radiomaters 1Papor 3D18491
H. Lee Kylt. Frederick B. Honse, Philip E. Ardmay, Herbert Jacobowitz, Robert H. Maschhoff,

H. Lee Kylt, Frederick B. Honst, Philip E. Ardmury, Herbert Jacobowliz, Robert H. Maschhaff, and John R. Hikkey
An Assestment of Nikibus 7 ERB Shortwave Scanner Data by Correlative Analysis With Narrowband CZC8
Data (Paper 101972)
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Albert Arking and Susted Ventury
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Experiment on Nikibus 7 Paper 10145bt
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Herbert Fischer, Andre Gleard, John E. Harries, and Wayne F. J. Evans
Simtospheric Water Vapar, Hirogen Uioxida, Hiric Acid and Ozono Measurements Deduced From Spectroscopic
Observations (Paper 101674)
Validation of Woter Vapar Results Measured by the Limb Infrared Monitor of the Stratospheta Experiment on
NIMBUS 7 (Paper 2017)11

Yamusion of Woter Vapot Results Measured by the Linux annual Larry L. Gordley, Paul L. Balky, Herbert Fischer, Mis Bus 7 (Paper 101711)

James M. Russell III, John C. Gille, Ellis E. Remsberg, Lurry L. Gordley, Paul L. Balky, Herbert Fischer, Andre Girard, S. Rohnd Drayson, Wayne F. J. Eunus, and John E. Harries

The Limb Infrared Monitor of the Stratosphere: Experiment Oescription. Performence, and Results (Paper 301711)

John C. Gille and James M. Russell III

Spectroscopy and Transmittances for the LIMS Experiment Paper 30 18471

S. Roland Drayson, Paul L. Builey, Herbert Firther, John C. Gille, Andre Girard, Larry L. Gordley, John E. Horries, Walter D. Planet, Ellis E. Rengberg, and James 11. Russell III

Validation of Temperature Retrievals Obtained by the Limb Infrared Monitor of the Stratosphere (LIMS) Experiment on Himbur 7 (Paper 171072)

Validation of Temperature Retrievals Obtained by the Limb Infrared Munitor of the Stratosphere (Lima) Emperature on HiMOUS 7 (Paper 3D1923)

John C. Gille, James M. Russell HI, Paul L. Balley, Lorry L. Gordley, Ellis E. Remsberg, James H. Lienesch, Walter G. Plonet, Frederick B. House, Lawrence V. Lyjal, and Sharon A. Beck

The Validation of HIMOUS 7 LIMS Measurements of Ozone (Paper 301961)

Ellis E. Remsberg, James M. Russell HI, John C. Gille, Larry L. Gordley, Paul L. Balley, Walter G. Planet, and John E. Horries

Accuracy and Precision of the Hitric Acid Concentrations Determined by the Limb Infrared Monitor of the Stratosphere Experiment on HIMBUS 7 (19per 301982)

John C. Gille, James M. Russell HI, Paul L. Balley, Ellis E. Remsberg, Larry L. Gordley, Waynr F. J. Evans, Herbert Fischer, Brace W. Dondrud, Andre Girard, John E. Harries, and Shuron A. Beck Stratospheric Ozone Changes During the First Year of Souly Observations (Paper 302131) Average Ozone Profiles for 1979 Prom the HIMOUS 7 SBUV Instrument | 1Paper 3C05131 R. O. AlcPeters. O. F. Hooth, and P. K. C.

Some Aspects of the Design and Behavior of the Stratospheric and Measspheric Sounder. [Paper 30 is 1]

It is a sounder of the Design and Behavior of the Stratospheric and Measspheric Sounder. [Paper 30 is 1]

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3199 General A BIN-MAX APPROACH TO RESERVOIR MANAGEMENT 3. Orlovski, S. Sinaidi iCectro Yeorla dei Gistoni, Politacnico di Milana, Milano, Italy 12013f), R. Ronri-J. Nonnorous (RSMAE, University of Mani, Piani, Pi. 13148; C. Parel and R. Nontings,

Onetsuic amphibolites, serpentinites and stagesbrow were recovered by 2 dredge-hauts from the foot of the corth feeling slope of the transverse ridge forming the south wall of the weak Frecture Rome. The amphibolites were probably derived from various types of qubbrolo rocks which completely recrystalised under stress in the conditions of the amphibolite factss (besween 350° and 850°Ci. The amphibolites were affected by a very slight and restricted retrageade moteophism, possily when the transverse ridge was uselffeed to higher levels of the counid crust. The associated extraphibrous delaying secondary minoral paragenesses indicating more complex cooling and seferacted indicating more and amphibolites. It is tentatively concluded that the special amphibolites it is tentatively concluded that the special amphibolites of the formed as a result of intense hydrothermal reactions natures Layer t gabbros and sewater derived solutions. Sak dealing suggests that the amplibolite facine contamphism occurred about 10 My aqu. I.e., when the dredging mitted on the southern wall were located in the vicinity of the Mid-Asiantic Ridge. Sydrothermal citymorphism; the fracture sone was activated by esplacement of beautiff pagents at the spreading conter. Rephibolites, fracture sones, hydrothermal categorphism; ni-Sessa.
A deturministic inin-mant approach to teal time oper ation of a multipurpose reservoir is presented in this paper. The use of this method is particularly justified when the attention and effort of the manager are mainly lawread on avoiding substantial failures of the system during substantial failures of the system. during severe hydrological relations (rick-averse attitude). The approach does not require complex algorithms and on-line optimization, since all ellipticat operating rules can simply be obtained by off-line repetitive sileases, hashed of a single value, thus introducing some fluxibility into the decision-making process. The ana-lysis of a real case has also shown that this daterain!

Meteorology

multations of the reservoir behaviour for different va-

empty the method suggests a whole range of possible re

Physics of the Solid Earth

Volume 19, Number 6

1715 Chasical composition and chacteal interactions of ASALVSES OF TAS Actual CYCLE IS UEFE STESSO-SEESE COOSE

J. f. Fraderick latocapheric Checketry Reanth, Code 964, SASI/Goddard Space flight Cenfer, Greenbeft, Haryland, 207714, O. e. Saraline and A. I. Douglass The Old-leftleds upper stretonpheric scene profiles octained by the "olar Aliventer Tibraviols! ISBNC: Instrument on the Simbus 7 ambilities now a class annual cycle both in the absolute ozone amounts between 0,98 and 15,6 th and in the magnitude of disturbances which reveal Phemaelvas as longitudinal atructure. It the lowest pressures analysed a winfer nazinae in ozone asiefs, but as one progresses downward in mititude a shilt in the temporal phase of the annual cycle construction of the observed behavior with the predictions of a one-diseasical photochecies model shows a spefacefic tenders for celeulaced commentary. The both the observed behavior with the predictions of a one-diseasical photochecies model shows a spefacefic tenders for celeulaced commentary. The both is observed behavior with the predictions of a non-diseasical photochecies model shows a spefacefic tenders for celeulaced comments of the change in phase of the annual cycle, sithough at a greatest than observed ability to be closely completed to the signification for the scene column density campided to the signification of the scene column density campided of the molecular cryging and ozone disconlation refer, leading to a change in the temporal phase of the annual cycle.

J. Goophys. Res., O, Paper 400850

3720 Elimatelogy
CLOUG OPTICAL THIEMRESS FEEDRACKS 18 THE CO₂ ELIMATE
PROBLEM
R. E. J. Somerville iScripps institution of
Commography, Elimato Besserch Broup. A-024, La Jolla,
EA 92093], L. A. Remer
A radialive-convective squillbrium model is developed
end Applied to stady cloud opticel thickness Faedbacks
in the EO, Elimata problem. The busic hypothesis is
that in the warmer and solgier EO,—rich atmosphara,
cloud ifquid water contret will generally be larger too.
For clouds other than thin cirrum, the result is te increate the sibedo more than to increase the greenhouse
effect. Thus the sign of the feedback is segatice:
cloud optical properies act as A thermostat and aller
in such a wayes to reduce the surface and impospherit
warming caused by the addition of CO₂. This competive
feedback cen be substacted. When observationel
estimates of the temperahum dependence of cloud liquid
water content are employed in the model, the surface
tamperature change due te doubling CO, is reduced by
shoat one half. This result is obterfine for global end
ensual average conditions, on change in cloud amount or
elitude, and constant reletive humidity. Those ideelizations, together with other simplifications typical of
out-directions the result lendelive. Luriber Ludy of cloud
optical property feadbacks is warrusted, however, because
the elimate is memarantly so centilive to them. Cloud

oplical property feadbacks is warrusted, however, bacaus the climate is apparently so sensitive to them. (Cloud feedbacks, climato omdelmi.

1799 General IBadiation Badget]
LORGMANN RADIATION BALANCE INDER A STRONG BURNACE
INVESTION IN THE RATABATIC WISD ZOOR, ANTARCTICA
T. Temescubi and S. Kawaguchi [Sational lestitate of
Polar Rasearch, Isabashi-ku, Tokyo, 171 Japas;
Hessurements and baloniations of longwave radiation
Fluxas were sade under the Japases POLE progras,
1919-81, at Hissho Santion 170-112, AA-20-21, where
the harshatic wind was binsing continuously sade
atrong surfoss [eversion seleted. Dounward and upward
Longwave fluxas years asserted directly unian pregaracters with a sheding ring. Sameriral galtulations
were made using a wide badd model. The affact of
clouds is laggal overcost shims give as interess of
about 80 Wim To the downward Flox is all massous.
The usuall assemt of column water wapor yields the
effactive emissivity of the stomephere small. The
difficing now Lorraness the decompted congave flux
and suppresses the longwave flux is aboum. (Radfacton,
suttees inversion, Ancerecips).

Mineralogy, Petrology, and Crystal Chemistry

OROTECTORIO STUDIFICANCE OF CARRESC ANDSTRUCTES FROM THE YEAR PRACTURE EXCE, EQUATORIAL MED-ATLANTIC DEDGE

Oceanography

4705 Goundary Layer and exchange processes
DUAL RADIOTRACES MEASUREMENT BY ZOOBETHOS-MEDIATED
SBLUTE AND PARTICLE TRANSFORY IN FRESHMAICE SEDIMENTS
J.R. Kreaceal I Center for Greet takes Studies.
University of Misconsin-Milysubase, Milweuheg,
at S52017. J.A. Robbins and O.S. White
Ceams epactroscopy methods were used to determine the
effacie of free Iroubwater benchic mercinvertebrates.
Stylodrilus haringianus joligochesie voresi and
Pontogorals hayi Crustateen amphipodal, on the
reworking of sediments and the transfer of miscou
terots for todirent-water inforface. In laborator,
microceanu submillimetar isyers of 137cs itseled soilus
were deposited on the anginant surface while overlying
water was apited with *No.
In colle with Stylodrilus, the 137cs itseled soilus
were deposited on the anginant surface while overlying
water was apited with *No.
In colle with Stylodrilus, the 137cs isyer moved
downsind at an apponentially decreasing rate. The
displacement of the layer results from the conveyor—
built leading adds of this organism. The rate of marked
isyar burief is consistent with that of other
freehwater smarids (1.2 x 10.00 cm day-1 individual-1
e-21 11.60cl. The exponential decrease in burief rate
is sacribed to uniformly distributed feeding of
Stylogrilus within the lenging rate of 4.4 cm. Is
celle with Pantoporais, 137cs activity was secured
downward in ting dwing to day diffesive mixing of
sediments over a sessi range (1-2 cm).
In celle without some, the Ce active meterial
resisted at the interfess while the *2-Ne peatration
into eachesies was consequent with diffusion is free
stultion with small corrections for sedions promity
and sorption Kg.- 0.171. The effactive diffusion conficient for *2-Ne 182, v. 10.00 cm 2 sec-1) was into escinairs was considerent with diffusion is free tolution with small corrections for sections for sections for sections for sections for sections for section for Section 107 274m 18.2 x 10.00 cm² sec-1) with escentially the same as that for a cell which had been inhabited by worms for throw wests und then poisoned with lormatin just before edition of 274m. Thus, the presence of biogesiasily reworked undimnum letter of the presence of biogesiasily reworked undimnum letter of 24m and the presence of biogesiasily reworked undimnum letter of an only with live styledrilum, penetration of 27m within the leading some see considerably core regid. Implying an upparent Styledrilum, penetration of 27m within the leading some see considerably core regid. Implying an upparent O, fixtee as high as in cells without words. Particle reworking results were used to develop a transport andel which includes edvective as well as diffusive terms. Advective transport arison long the incorporation of 27m into pore folds moved downward as a result of conveyor-balt feading. Within the feading sone, solute framport is dominated by severtion and the apparent schemes of 0, is pure diffusion models to really the result of onlute flow indused by particle reworking. In onlie with Edutoropial O, is approximately to be that is control calls. In these calls 27m proline may be treated theoretically within advection. Biotarbation!

COLLECTIVE CAPTERS OF RELEASED LETHIUM form the SOLAR WHATD O. Whether the Alamos Entioned is barratory, is a Alamos, Mr. 3754f), C. & Mu, Y. Y. Li and O. C. Zhou The septure of savily iceraed fathium lone in the solar wholey mease of electromagnetic iconcabilisties is investigated through lisser analysis and computer elementation. Three inputabilities, driven by a fithium variesty ring that in superiorium to sud deficting parafiel elong the magnetic finald, are considered. The repute time of the lithium by the solar wind is roughly tep lioner growth times, regardless of whether resonant or coveragement ander dealors initially. Possible fapilizations of the reputate for the AMPTE slesion are dishussed. (Flamms instabilities, solar wind).

J. Goophys. Sas., A, Fapar 440883

J. Monnoton (RSMAE, University of Miani, Miami, FL 33148), C. Mewel and R. Montigay,

J. Ceophys. Sec., B, Papar AB0175

We derive a simple assiptical rodal of the boundary isper induced by rolery ridal currents flowing over a noricoted bolion is she absense of acrong vertical attractification, farmisting mapicity selions as sheer votocity, dissipation, and friction focsors relating invisors velocity to borton shear strong. Thems friction fracrott may accordingly be calibrated by an observed volocity grafile through the cortry botton boundary layer, sheraby reducing the empiricism of existing depth surrayed models of ridel hydraulics. We illumerase the procedure by analyzing mestured \$2\$ rotary currans profiles on the outer Seropeon their with good sodel acturacy; the local dissipation-based frierion factor comperes fovorably with a global value based upon a calibrated nuveries: model of the north-west European shelf as well. (Soundary layers, borton frigrion, ridat currents). J. Gaophys. Ras., O, Papes 4CD836

Interplanetary Space

Morocholk V. S. Scattering of alastic shear wovas by a weakly contrasting spharical inclusion

Vonek I., Kondorskoyo N. V., Khristoskov L., Federovo I. V., Arofyova L. A., Antonov V. V., Verobyovo E. A., Gevendyon V. B., Geleociskaya I. G., Grin T. P., Guinrich B., Dorastkina N. M., Zoonnov M. Ya., Zakharova A. I., Kazin E. A., Lazorevo A. P., Medvedevo G. Yo., Malorina T. V., Novitaknye N. A., Odiorina S. F., Slocialkova L. G., Sitaikovo T. A., Sobotova V., Soloniaov A. P., Ulemova N. V., Fabritsius Z. E., Ferchev M. M., Titol B., Shelornayo N. V., Stelzoor t. Stelion forroctions for P., S. and aurfoce wave to the uniform magnifude system of the Eurosien continest

Rummoi F., Sobolev G. A. A etudy of shear cracking and seismic wave propagation in specimens conteioing low-donsity inclustoos

Kissin J. G., Bayabanov V. L., Grinevsky A. O., Markov V. M., Khudzlosky L. L. A soorch for hydrogeodynomic earthquako precursors using groundwater flow doto

doto
Petrunin G. I., Popov V. G. Lattice heet conductivity end its betravior at the upper

mantle Interfaces

Particles and Fields—

421

Volume 23, Number 3

Rezulk G. M. On a generation pendiarily of the Rossby waves in a stratified ocean 373 Seldov D. G. Numerical sympotic forecasting of energits of the POLYMODE poly-Makov Yu. N., Stepanyants Yn. A. On parometers of growing waves in shear flows Korolenko K. A. On the vertical matter flow in the ocean with stratified structure

of the current velocity field. Daricheva L. V., Chapryulu V. I. Experiments on sumulating aelf-oscillations cauaed by the occul-ntuosphere interestion summating aem-oscinations caused by the occul-ntuosphere interestion.

Kortinskilla N. N., Lozovatsky I. D. On the formation of a litin-layer quasi-periodic distribution of the theoryealing with the statement of the control of the statement of the stateme

die structure of the thermocline near the frontal zone

Bubnoo V. A., Egorikhin P. D. Equatoriol currents in the Pacific Ocean along the Mozgovoy V. A. A sludy of volume senttering of ultrasonic waves in the East Allandic

laulic

Leont'ev I. O. Helght transformation of Irregular waves in the surfizone

Moleck V. M. Diagnostic eoleulations of water circulation in the Australian and

New Zeoland sectors of the Southern Ocean from the data of the POLEXSOUTTILE Expedition SOUTII-81 Expedition

Kosov A. E., Suchkoro G. I. On a possibility of the formation of the ion pairs

MgCl+ and CoCl+ in sea water

Kvosov D. D. Causes of the sharp regression of the Block and Caspian seas about 5 million years ngo Schreider A. A. Palcomagnette interpretation of the linear oceanic anomalies ΔT

and its limitations

[100,0000 E. V. On a paleotemperature numbers of planktonic foraminifers . . .

Krivosheya V. G. On the onelior system of the GM-51 type self-continued moorlings Neprorlinov Yu. P., Ropoport M. B., Bogogaviensky V. I., Grin'ko B. N. Improvement of computer processing of bottom setsmograph recording during deep selsmic solutions in the ocean Gazneyan R. M., Dikinov Kh. Zh., Shukhovo L. Z. The use of empirical orthogonal control of the control luncilons for the description and classification of sound velocity clevation pro-

liles in the ocean Agalovo A. I., Torgunovo N. I. Delerminolion of proleins dissolved in sea water and Interstillal water from bottom sediments

Kuril'chikova G. E., Luknshta V. N., Demino L. L. The use of Inversion polarography in the complex farmation aludies and in the numbers of copper, lead, cad-,

mium siid zinc in sea and river objects.

Alexondrov A. A., Vareichiek N. S., Osheverov M. G., Fuks B. K. Determination of sea thore characteristics using the phase side-scan sonar.

Rimsky-Korsakuv N. A., Rutev A. S., Sychev V. A. Detailed geological-geomorphological studies with the use of submerables.

503

To the memory of Professor Gelly Grigorievich Neoymin (22 March, 1910-22 Au-

Particles and Fields— Ionosphere

5305 Lirgiev

AMAINTICAL FIRID OPECTRUM AFROACH TO PHOTOELECTON
FIULIS IN THE ELECT OF ATHOUSESTEE

R. P. Singhal [Applied Physics Section,]settlute
of Technology, Beautra Blinds University.
Varamati, 221005. India] and S. A. Maider
The analytical yield spectrum approach has been
applied in anionists the photoelectron fluxes in
the earth's atsosphere. The results have been acquared with the apprisental data of Les et al.
11980s, bl. Good agreement is obtained at low nitTwises, it high allitudes on theoretical results
are lower than the experimental deta in the 3543 eV by a factor of 2. Comparison with theoretiall administices performed by other workers showe
that if the sease set of inglastic electron import
cross sections had been used, then the photoeloctron nodels af Strickland and Anderson (1983) and
Sinhard and Torr (196)) would be in good agreedant with our work and the experimental data.
Soverer, the photoelectron fluxes calculated by
the model of Victor et 11. (1976) as not scariatent vith the other theoretical models or the expeinsectal data.

rimental data. (Photoelastrons, flux) J. Gaspert. Pas., A, Papec 4AC569

SSIP Aurotal some Charactic affects
CORRELATED LOW FRENCENCY ELECTRIC AND MUCATIC NOISE
ALONG THE ATRORAL PIELD LINES
O. S. Garnett tempatement of Physics and Astronomy, The
Undersating of lows, lowe City, IA 1214ft. E. L. Ruft,
J. O. Manietti, J. L. Sutch, J. D. Winningham, and
S. O. Shawkar

Plants wave and plants becausements from the Df-I
spaceralt size used to investigate so intense band of
low frequency, C 100 Mg, electric and campetic noise
detected at low altitudes over the suresi somes. The
notes is observed by Df-I on essentially every fon
airitude pass over the sureral some and necurs in
regions of intense low energy, 100 eP to 10 keV, elsetron precipitation and fishd-eligned cuesants. The
stactric field poistiration in a plans patpendicular to
the scarle magnetic field to random. forrelation meaaurements advers the electric and magnetic fields show
that the perpendicular f- north-south) electric field
fluctuations are closely correlated with the perpendicular (sear-wear) wagnetic field fluctuations, and thus
see toynting flux is distacted downerd, towerd the
Berth. The total electricingnetic power flow secociated
with these fluctuations is very large, eppoorimately
10th watte.

Two general interpretations of the low frequency
usias ate considered: lirse, that the noise is produred by static fields inhedded in the isomophure, and
second, that the object to use to Alivan waves propagating along the several field lives. Second, that the object to use to find ratio
decreases rapidly with increasing height. This height
dependence is le strong disagreement with the static
model unless a parallel electric field eviter sinough the
available for the height dependence of the au-

non-zero paratial electric field.

The Alivan wave moint is in good agreement with
the general form of the height dependence of the annotic is cleerly iteld ratio, but disagreem in certain
detain such as the lequency dependence and majatuds
of rBMS, which is usually somewhat larger shan the computed value of the Siren index of reflection. Bose of
these difficulties could be accounted for by tellections and propagation at large angles to the magnatic
dield. It be majate induce to Affect waves then the
noutce must be located at high sittudes, since the
avetage Toynting (but is usually distented downward,
aven as radief distores up so 2 Mg. (Mirctic Heids,
magnatic fields, Sifvan waves, autored field lines).

L. Gentow. Nume. A. Papet A.095h 1. Gcophys. Mes., A. Papet 4A095h

cond finance tites, consection, or catalities Figure correction in the Wilfelfe of the latestate care in C. Folier (Mercathwells Roedland of Technology, Hoyaless old residency, Scottonia, Macachimotta, (Most), Jr. R. Legalt Laggelessia conducted with the Chimotta, Alaeba

In a logarity in conducted with the finiants, Alson Interpret of the property of the property

inser inilises in the aftersees sector. Such pleams, seen at very high inilised within two point cap, serves as a treatm of the convection pattern user from the claft. (Flame, convection, innusphese, claft).

J. Geophys. Res., A, Caper 4A0855

Particles and Fields— Magnetosphere

6705 for mak enter HIGH TIVE RESOLUTION STUDIES OF UPSIREAN IONS GRES (Now should nave MICHT) FOR STONES OF UPSTREAM IONS Kirsey A Anderson 120-bes Storme Internator, University of Collifornia, Scriege, C. 49-9700, M. & Leveckill, R. P. Len, and G. K. Parks.

Onfluse quatrages how at les county [1-10 keV] fluctuate reading compared to high recovery some of says in internity in a system case, any write g, the engle between the interplanatery magnetic field, \$\frac{1}{2}\$, and the Corth-San direction. The 1 of lev's ton internity is highest where y in the range of to 60° and there is now any nearly despet for visions of grass O'. There is a nature searcy merch on the flux ruration remarkably constant. At large tile setting information in the high current of an evening on the 10 keV and of other times as low as 0 keV. This energy appears to vising any of the many flux of other times as low in 0 keV. This energy appears to very gettermically with the region, if it have does loand that low increases only on the setting of the provided with the properties of the provided with the properties of the provided with the provided wit

J. Genphys. Pes., A. Paper 4807PG

5f20 interactions between solar wind and magnetosphere total type (Alfatica is the missoure of to the Samuel Section to the Samuel Section to the Samuel Section to the Samuel Section (Samuel Section which the origin of the pulsations is proposed to be a Felvia-delchoitz instability at the interface between the Low-institute houndary layer and the control plants wheet. IGoorgnotic pulsations, substorms, Kelvin-Helcholis instability).

J. Geophys. Res., A, Paper AA061b

5739 Magnetopause

OSSERVATIONS OF SUMMARD PROPAGATION SAYES
ON THE MAGNETOPAUSE
E. Milelien [Mas-Plenck-Institut für Aeronomie,
D-1411 Kotlonburg-Lindsu, FRG)
Obsorrations of lonosphoric electric fields during
on ULF resonant symal are used to infor the pratence
of we'vee on or near the magnetopeuss propagating toward
the dayside. Sizeliandous saielitie measurements et
goosynthronous orbit confirm the prasence of these surnece sayes. Irrectlesby following shoto observations o
flux transfer event eppcars to here occurred (Exerts
al et, 1984). It is speculated that the pulsetions were
essociated atth that event. (magnetopouse, e)actric

J. Geophys, Cea., A. Paper 140000

in the electrojes polities. These twent do not obevith pl2 period-electrojes latitude relationship obtained by Suvastime and Salto Liphit. J. Gaophys. Res., A, Paper 4A0857

5775 Trapped Periloles
PE-1 COMPTRANTONS OF TIPE-1 COUNTRANTAMING
ELFCTRORS ANT FIELD-ALIGNED CURRENTS
C. S. Lin operations of Space Sciences, Southwest
Basedrob Institute. Ban Antonio, TX 702741; M.
Englura, J. L. Burch, J. M. Bertlaid and E.

Bagere's Institute, San Antonio, Tx 70,784; M. Saylura, J. L. Barch, J. M. Bartlaid and E. Siglura, J. L. Barch, J. M. Bartlaid and E. Siglura; J. L. Barch, J. M. Bartlaid and E. Siglura; J. L. Bartlaid and E. Siglura in this article we report that the Dynamics Explorer I tatallite frequently detected type 1 onunterstreaming stations in the replon of fleld-aligned currents at high alictudes in the nigeties everal sons. Type I counterstreaming electrons are generally detected at energies below a few bundrid evi in association with energies below a few bundrid evi in association with energies below a few bundrid evi in association with energial to the association with energial to the association with energy the association analysis and security according alictron flomes and counterstreaming leatrons to the Held-aligned current density. The current density is computed by integrating the two-disamsional alactron distribution functions in two energy reages: the 235 evi ad 32-10000 ev. In the case of downward current, low energy 10235 evi electrons are found to marry more than 600 of the total plants current density the tatt. In the case of upward current density, while higher snargy electrons citry the tatt. In the case of upward current density is found to be constrained by lates ourself density le found to be constrained by lates ourself density le found to be constrained by lates observed putter angle distributions show that itumes of counterstreaming electrons are anhanced at both mail (4491 and large 1:1404) pitch angles. The energy spectra of counterstreaming electrons to the little enhancement in the functions and occasionally by spectral pashe. It is those concluded leat connecrative and gelectrons contribute to field-aligned current density social counterstreaming electrons and counterstreaming electrons and counterstreaming electrons and social counters the solutions. The START rader signal tensoos observations indicated that the upward and docurrent densired by Et.— was closed this two observed tons indic

578D Maye Progenation
GOVIAN DECAMINET APPER AN ESTIMATE OF THE REQUIRED WAVE
MORMAL MARKES SHORT THREE-DIMENSIONAL MAY TRACING
J. O. Meniett | Gouthwest Researce Institute, P.O.
Oramer 28510, San Antonio, Team 18204; J. t. Green,
S. Golikis and P. Six

Olio elasticity, fracture, and flow
MEAR SURFACE IN SITU STREES PART IT: REGIDUAL STREES
IN THE TURLE LURGATORS, APPLACUIAS ELATEAU, NEW YORK
I. Suguider (Leanor-Coharig Geological Observatory,
Salisades, New York, 10764), P. Gaiser
The direction of saximum expension during strain
released to the Tully Lieustone at Ludiouville, Now
York, is oriented show MOI'E and thus is within a
coughs of degrees of the strike of both set is crossfold joints and the compression direction indicated by
the teath of lectosic etylolites. These joints and
exylolites are members of a suits of structures accommodating approsimenticy P? I super-parallol shortening
during the main phase of the Alleghenian Grogeny within
the Applacelien Mountains. Secouse of the parallulisa
of the carigum expension with the main phase Alleghenian compression and because our messurgements were made
in joint-hounded blocks, we suggest that the sepansion
represents the relief of a residual strees locked into
the Tully Lieustone during the Alleghenian Oregany.
The magnitude of the strain releastion ladicates lost
the residual differentici stress was 14 MPa. Osing a
ilou law for pressure tolution, so (afer that the Tully
Lieustone deformed at a strain rais of shows 3 x
10015/acc, and thus the layerparallel shartening
observed in the Tully Lieustone may have required an
eggregate deformation lettered in only 1 Ma. its stree
stress, strain releastion, residual strees).
J. Geophys. Sec., S, Paper 420161

concorning the geometrical configuration (which is aputilizedly discussed in the present worth), have to be aputilizedly discussed in the present worth), have to the dealt with. For axample, among the saveral possibilities, protosputtering might be discarded due to its low preduction fulled of acous and the shearce of time facilities of the C Ly-siphs smission over the years. Fariation of the O Ly-siphe maission over the years. Interplanetacy mateerold inpart could fait by a factor oi 10 is providing the required emission race of the cino hydrogen atmosphere if the conservative setfmate for the lupacr vapour production rate is used; otherwise it is an edequate source. Exampharic spection of dissociated hydrogen fragments from the dayside disk is also promising, but we show that the global distribution of the hydrogen come in ballieric trajectories appears not the hydrogen come in ballieric trajectories appears not the distribution of the distribution of the distribution of the content of the content of the segment with the respected to the the magneto-spheric pleases but hear found to be a significant loss machanism of the ring atmosphere. In runn, the pitch-angle distribution and the content in please the form of the cortesting please could be attempt modified by the equiral closs as of neutry particles by depress exchange could vary hatman Aulo's mod field's 1. (Saturn rings, bydrogm atmosphere, charge exchange).

J. Geophys Sea., A. Reper (An790) J. Geophys: Sez., A, Taper 4A0799

Tectonophysics

Silo Convection surrends
GEOFFRAIRE ON MANTIE
GEOFFRAIRE AND INTURES CONSTRAIRES ON MANTIE
CONVECTION: AM INTERIS STRINGESS
Geoffray F. Daviss (Sessands School of Earth Sciences,
Australian National Undwarsfty, P.O. Box 4, Camberra,
ACT 2601, Americally,
Ottootium and ishd isotopid data from onsenie rocks;
seem to require out jest two ot three but many ancient
annis Sources, and this sould remove the gamb benical
teliosals (for manyle layering, Mithough it would not

proclude latering. Seamount data require that at less proclams taken to the conjunction of the process of all large units and the conjunction of the process of the conjunction in the upperson units. There is no conjusting independent related that roke with chronicities model in incompanies and darived from a printing mattie nonzee. It intoms that rooks with chrondritte decode inclinations are durined from a printive mantie amone. It lottons that isotopic conrelations do not not necessarily constraint proportion of depicted mantie or the mean silicate cor "bulk earth" values at Sr and Phincopic compositions. Several recont geoglevated argument concorring the mantie viaceatity profile, assisted extensions of Bentat rooms, and the anglos and shapes of denied rooms indicate that mantie flow stociated with the plates pearts attended into the lower martialities would probably preclude chemical layoring at each above the transitions room. These arguments togged a mantie with betweenorphic to many sizes and compositions at all depths and with any attentication confined to roughly the bottom half. Such treatification of the roughly the bottom half. Such treatification of the roughly the bottom half. Such treatification of the roughly the bottom half. Such treatification olight result from a pressure-induced viscosing forces with depth or from gravitational sattling accounting the longwitty and loss buriers, and the longwitty and loss buriers, and the longwitty and loss buriers as a long of sche but spate. Possible assures of mantie heart-grounties include recycled occasic and continuital crust, dotathed continental lithospades, and savylving primitive mantie. [Hant is empection, lectops.]

0150 Plate Tectosics POBOTOLS PERTURANTONS TO BOTSPOT TRACES AND INPLICATIONS FOR THE ORIGIN AND STRUCTURE OF THE LISO ISLANDS

LISO ISLANDS
Onvid Epp (Hawait last. of Gaophysics, Monolulu Pitz)
There are sementic differences in the way the time
hotspat is used to the literature. Sees the view is
taken that hotspats are deliced by the observatisities
of being thermal associates that are lised relative to
asch other.

taken that hotspate are suited any tos separatallities of heing thermal second to that are ideed relativest each other.

Parturbations to bettput signals recorded on the surfact of the earth will produce heteopt transfell the surfact of the earth will produce heteopt transfell the parturbations are a consequence of normal plate tectonicer, some tre observed interactions of these parturbations are a consequence of normal plate tectonicer, some tre observed interactions of heteopt sequentiam with likhotphasic structure and processes, and others are hypothetical.

The Line literade volcanic chain het e tomplat attructure and some characteristics that cannot be recorded with those supected of a timple flow-progressive hettpat trace. Two models for the derecordinal with those supected of a timple flow in an easier that the line leighed ware formed hetween 10 and 6f Ms 8.P., and Modef 2 sesums an ent apte of 90 to shoot IP Ms 8.P. and incorporates the Theorem Islands are mantansion of the Line literate. In Model 1 most of the complex structure and subsidence of the chain case be mapliabled to terms of parturbations to the chain case be mapliabled to terms of parturbations to the head of the volcanic chain hat fails to emptin the semantage authatiance of the Line falands. (Rotspet, Line lighted).

1. Geopys. See., 8, Faper 480639

North Angles sum inflamentarion and the process of the line 2 p.d., or are 2016, San Antonio, Team 72044, J. t. Orean, S. Golits and P. Sit.

A toter-diseasional tay training code which incorporates the D-4 magnetic field sode! Uncurs and bears, 1979, and a rasitatio please model has been used to acids high-nurvasure decements are chearward by the Vogaver planetary hadro Antonomy (SMI instrument, Two semples of instance, isolated, cettain-late, high-curvature ares were slegied out for atoly. The source point shows the semple of the first seen seasoned at seaso of a foll range of the semple. The source point seen source are of the SMI instrument, the semples is requested to the source point instance, an access to great a foll range of the semple of the first seen seasoned at seaso of a foll range of the semple of the first seen seasoned at seaso of a foll range of the semple of the semp

In Sungition (Lance-Obbarty Geological Observatory, Seliasius, Ray York, 1984), P. Gelser

The direction of carisma expansion during strain releasation of the Tully Licastone at Landlowvilla, Nov York, is oriented show MOL's end that is within a caugis of degrees of the strike of both set is cross-fold joints and the compression of irection indicated by the least of testing of the conditions of the condition of apply to other convergent plate anygles at which write uplift rate of the accretionary prime probably mries uplift rate of the accretionary prime probably along the transh; and is laterly identificant of vertacless in the loss sediment accretical at the formation of several different types of forest in the formation of several different types of forest stops and the formation of the West losso Trough forest sic stretigraphy of the West losso Trough forest sic stretigraphy of the West losso Trough several hain is remarkably onifore, with asian's several sector continuous for up to 110 im along strike. The sector formations for up to 110 im along strike. The sector formation that have been been several to be sector of the J. Geophys. Res., B, Paper 480812

OIPO Plata Tectonica
A ODDPHYSICAL STUDY Of THE MAMILA TRENCH LEGIT,
PHILIPPINES, PART 1: CRUSTAL STRUCTURE, GRAITI, HE
FRILIPPINES, PART 1: CRUSTAL STRUCTURE, GRAITI, HE
SEMICHAN, TROTONIC EVOLUTION
Genules E. Hayes end Simphes O. Lawfs (Lamos-Dohn's)
Genules E. Hayes end Simphes O. Lawfs (Lamos-Dohn's)
Genules E. Hayes end Simphes O. Lawfs (Lamos-Dohn's)
The Haolia Tranch subduction more in an antive office of the tranch subduction more in an antive office of the tranch and contain subduring the enthann fullippines. The treech transfer surburing and is associated with a calonic and, on east-dippined to associated with a calonic and, on east-dippined and is associated with a calonic and, on east-dippined and in the form the subducted in the function of the full associated of the function of the functio

otually forms near the amountoreity superating the healpaingic sediments from the raphidite teditants. Subjection and prince accessory the deformation and accession of the overlying cleatic deposits. Faulting and uplift occur within a carten zone of the forearc where sensonne associated with the relict spratting center of the South Chint Sea hasin have presumably been subjected. North of Liegages Guif the forearc is ditrupted by artive fault system that trend north and northwest offshore from the Lucae Central. Fated on regional gaslegist and teatonic observations, we last that subject on probably began at the Hanlia french in Late Ulingacens as Middle Minorens tites. The fong-tors everage convergence rete at the Manila Treach it extlement has be between 10 and 20 ms/gr, and may be slucing in the north the to the callings of J. Geophys. Rea., B, Paper 4808us

8150 Testonophysies (plets tectonits) structural Francock of the GULP OF ELAT (AGARA) -

SING Testonophysies (plets tectomics)
STENCTURAL PRANEWORK OF THE OULF OF ELAT (AQAIA) —
MOTHER HED SPA

741 ben-kveakes, Copertaint of Camphysics and
Finelary Software, Tal Aviv University, larsal.
The Golf of List (Agaba) occupies the southern part
of the head Sea wife. The rift is considered to be a
plate boundary of the transform type (partially lasky)
which connects neefloot presiding in the Rad Sea with
the Lagrat-Taurus area of continents (onlisins. The
days waitr in the Gulf of Eler, up to 1000 metare,
provides a rate opportunity as meaning the process of
continents ifficing by marked samphysical techniques.
The headymenty alone provides much information shost
office theres in this area. The fragmentation of the
crost continuous Archian-Africae platform is a complicated
process. Its shapes the erructure of the gulf which has
dratepod through continuing testonium, primarily comstating of faulting, because gasphysical and gasingled
audies of the Gulf of Elet including hartymetry, bettom
photographs, continuous mainage profiles, estamic tathe Sagret-Taurus sens of Continuated collisies. The step west in the Child of Filer, up to 1000 masses, provides a rave opportunity as sexains the process of continuatia fifting by marked such information than the process. The hadysarty alone provides auch information than the process. The provides auch information than the process. The provides auch information than the process. The shapes the structure of the gulf which has been found to the Cuif of filet including hathysetry, bottom characteristics, and the continuation of the Cuif of filet including hathysetry, bottom characteristics, and the continuation of the Cuif of filet includes the Cuif of filet includes the such of the Cuif of filet includes the such of the Cuif of filet includes the such of the cuif of the Cuif of filet includes the such continuation in the cuif of the Cuif of filet such that it is an interpreted as guild-sparts. The new data from the guif ouggest that classical models for the format of the benist prefer and cuif process. The shallow such continuation of the such fire the cuif of the cuif

6130 Figure tocronics EALMORPHATIC REFERENCE FOR CRMCCOTC MIGRATION OF MANYANT TRADATES

ALTANAMIC REPARKE FOR GRANZOIC MIGRATION OF ALTANAMIC REPARKES.

ALTANAMIC REPARKES.

O. Vellor, R., woe Husne, R. McDougall, and T. P. Brunn G. S. Gool oxical Survey, 325 Middlaffeld Poad, Maelo Pak, Gilfarnie Mang.

Sak, Gilfarnie Mang.

Choosatimityraphie and palonclisatic compensors of dictofesel is from despense cores, from anomics of an inclusivery drill halt, and from desdand tool of the Gilf of Alexe with Cheval microfasell membelogue of the Sarlh Americae continent anouldre conversions on the acrivate Mistation of the Yahnias black, thi films Milliam terrans and the Merifity films on the acrivate Mistation of the Yahnias black, thi films Milliam terrans and the Merifity films of alroisans and flare provide three main constraints.

(1) The Prince William toterans was in the present politiciae with respect to North America (at high lightests, 30° ± 5° M) by middla Rocone time (10-14 M2), consistent with anodata derived from peliconscent data, (1) The migrature positive in serie Focus 750 M2, 20° ± 5° anoth in middla Rocone 180-44 M2, and 15° ± 5° anoth to lete Kocene time (17-10 M2), these trustifes a continent within alexivation of about 10° since 10° Sections of the Perifect William terrans during forms the Perince William terrans during forms the Franze Marcas (18 M8), on 15° ± 10° Marcas (18 M8), on 11° ± 10° Marcas (18 M8), on 15° ± 10° Marcas (18 M8), on 11° ± 10° Marcas (

\$130 (Flate Tattonics)
ENERGYIES OF THE PSILIPPINE OFA PLATS
b. Englen, (Geophysical institute, University of
Algala, Yelrbinhe, Aleeka), S. K. Farewell, and D.
T. Karig

h. Environ. (Geophysical institute, Wilversity of Algala, Yeirbrinhs, Aleeks), S. K. Fardwell, and D. H. Iaris

Algala, Yeirbrinhs, Aleeks), S. K. Fardwell, and D. H. Iaris

Antipert. New instantaneous rotation vactobe electronic to the institute of automatic of the Philippine Sea plets relative co surrounding plares are determined that east eastly acclefy all available goological; geophysical and selecological chambrations elong the Philippine seasological chambrations elong the Philippine and Garolina-Neille, polan era generated from seat of tries introduced for agreement with: (1) slip vectors described from food agreement with: (1) slip vectors its class from food method for agreement with: (1) slip vectors its class from food method for agreement with: (1) slip vectors its class from food method for agreement with: (1) slip vectors its class from food method for agreement with: (1) slip vectors its class from food method for agreement with: (1) slip vectors its class from food method for surrounding for covergence at the Sagnet crough, (1) ottension in the Marians trough, (4) entension behind the Bonian tranch, (5) accession in the vectors Borol reagh, and (6) convergence at the Maceau reach. Trial Largis-Philippine poles are eliminated if predicted plate estimate of one arth observed plets entone. In intension, (1) in the property of the property of the season of the season food in the collines and rotation revers of the three best dicting paice are Euresia-Philippines 36.0°%, (1),0.4°%, 1.60°/%, Prolific-Philippines 36.0°%, (1),0.4°%, 1.60°/%, Prolific-Philippines 36.0°%, (1),0.4°%, 1.60°%, Prolific-Philippines 36.0°%, (1),0.4°%, 1.60°%, Prolific-Philippines 36.0°%, (1),0.4°%, 1.60°%, Prolific-Philippines and prolifical development of earthwester and new food leached by the partial detribution of earthwester and new food leached by the partial detribution of earthwester and new food leached by the partial detribution of earthwester and the partial some which quality against the structure of the large sea Tectonice, Paper 470655

Tectonica, Paper 470569

City Plate Testonius affice the August Definition of The Patific Northwest Conflictation was a terminated by the August Density and August (Arch Toysics branch, Brangy, Sines and Bosources, Disaws, Censis at August Titles early Interest in southern brages at about 5 - in a 10-5 cet, year for the mast 2.25 m.g. Tide gauges to Anthriton and British Columbia, and ten resurvayed leveling lines running mined from ind const, Indicate contemporary tendered idometo-the-east) till rate of some laid \$10-6 cet. year and ten invested in the running mined from ind const, Indicate contemporary tendered idometo-the-east) till rate of some laid \$10-6 cet. year averaged over periods of from 10 to 30 years. The leveling lines travers, and ten larrades out somes, dipping Capocota atreats | Platistosme (sips to 37), Mio-Pilcosme (dips to 30) and Econe (dips to 30). Southern Oragon from Cape Glance to the 10-60. Southern Oragon from Cape Glance to the 10-60. Southern Oragon from Cape Glance to the same direction as the underlying strate lines. Hence present-day deformation continues peat deformation of the constant ranges and is cost likely related to eative sundedtion of the duen de Puos plate. The sleep strate lipp, leak of hajor sative faults and historio werthquakes, and presence of very young bedding-planc Fault suggest that more of two combore deformation and sherianing within the overlying worth American plate is techn up by loiding rates than thrust faulting. Freesed morth-dining decreases rapidly sestuards from the Juan de Puos - North American plate boundary. A total of shout 25 km prof of personent sectioning could se countring within the North American plates boundary. A total of shout 25 km prof of personent sectioning doubted and shortaning cets are smiller to techne show a boundary and other subduction comes that here supervised great thrust aerthquakes. rates are smaller to those above many other subduction comes that here experienced great terrost sarchquature. Shile a high stel to rate excessed most Sautis. Weshington, hes bean interpreted as missis a train acquasistion before a terrust earthquates, the less for a fine-print estantially and the similarity of scortand long-rare deformation rates suggests alternativally that the sunduction beneate Weshington to section. The tesus has considerable lopincations for estando heared was eaten in the Paulin Marthwest and could be resolved by a search for the affects (or lack of affects) of premiserois openies serticization. (Subduction, tilt, shortents, geomorphology). Tecronics, Paper 470700

BISO Plane Tectority IMPLICATIONS OF DALECHARMETIC DCTA ON THE COLLISION RELATED SONDING OF ISLAND ARCS

Robert Accase Herthquase Research Institute, University of Yokyo, Bunkyo-Yu Tokyo, Jepan 113; Paleomagnetic studies from the barrians, Cestral Philippinns, Synkyus, Sulawest, Fili-New Sewrides all show calce dilarences to the ex-lination volume observed from indivious islands within tea seme erm. Comparable differences are not observed in the inclination values. A sipple plate tectonic solds would gredict that each island are should superlence the same rota-cion sings its entire impact as the place nowes around its rotation exts. Sathysetry from each of these are show that tea differentially records arounds of the upper plate occur in stound its rolation exts. sathysatry from each of these are show that test differentially rounted seponts of the upper plate occur in areas where the downdoing place certies a factore such on a sateounc chain, ritted occur in areas where the downdoing place certies a factore such on a sateounc chain, ritted occur in a satisfication of the harhywestic features and che discordant petensagnetic declination deta support on maxilier hypothesis of vogt [1973] that these features are buoyant some on the downgoing place which inseract with the margin of the upper plate. All a result of this letarection, its upper plate boundary is locally deformed in addition to the pelsocapastic ovidence, other yearly lead yeaphysical date from these areas suquest such this result of this letarection, but appears to be a quod outrestello between the delications in onlor structures account the omitision sees and the pelsocapanetic directions that extended the pelsocapanetic directions that extended the pelsocapanetic directions collision may result le eny of the following sectonic processes: If slip files style striangly faults stoud the areas in the polarity of the subscended processes in the polarity of the subscended of the appear plate [Tapponniar et al. 1981]; If changes in the polarity of the subscender owned the areas of the indenter; or 4 reorganization of ton series plate pargin. In addition, deta from the Maxings, omithers on the collision released detaysation.

Volcanology

8699 Folcomology topics OYROCLASTIC OCCUPAND CALDERAS ASSOCIATED WITH STRONGER

evercelastic solds and calberas associated with strongle Prantaling Annualism G. A. Mohend Dept. of Coolegy, Stanford University, Stanford, CA 43051
Strongly parablaline volcante complexes tend to be whileld-like due to collescence of low-wiscosity laway from nucorous vent areas and blanbating by pyroclastic lions and falls. Dense welding and resonanting proclastic lions and falls. Dense welding and resonanting common falls are common, Solativoly low orgetive column produce poorly sorted purion falls that are difficult to distinguish from topography-mantling pyroclastic films, welded fall deposits are chapacerized by multiple, line-scale, welding towersale, welding resetation, and by listinguish of figure parallel to underlying wlones, whereas action loopography-mantling infinitelies are have fine-praised basel lawers, lithic lesson, inhibitable firster, and perintons in capani centent onlying the parallel of the pography-mantling intended on farger airs with topography-parable. Inhibits are relatively small, typically 1-0 km in diameter, with little ordered for standards we buildence in excess of a low bundled octors. Heavy strongly persisted and practices and active content show seldence of two or two needed coloctus, and partial reactivation of aidear ring fractures in corresponded to the coloctus of older ring fractures in corresponded to the coloctus of older ring fractures in coloctus.

subsidence structures. In sugaral consers, the caldera-forming unit is zound from pantelierite to more crystal-rich trachyte. Policeing collepse, trachyte forming unit is zoned from pantic librite to zone crystal-rich tractyte. Polloning collapse, trachyte lawns corronty wrupt from a contral want on the colders floor, building a cone that nearly fills the calders. Re-establishment of feostatte equilibrium mag he accomplished both by sruption of thems laws and by flow of trachytic of more mafte magon into the reat zone beneath the volcane. Resugant doning tenses and beneath the volcane. Resugant doning tenses stirty has not been decuremented in serongly peralishing systems; at Ponisiteria and Mount Suawa, however, the central portions of the conditions blocks atto uplifted and tilled. Atgus reservoirs that foud exploitive cruptions generally are challen, on indicted by pyroclastic units that contain lithic fragments of the volcants udilice (encounty including cosmic systies) but lack subjecton crustal lithologies. In addition, the overwholding pradominance of sibali faidspar as a photocryst phase and the teartity of quarta are consistent with partellarity injudice relations only at pressures greater than 100 MPs. Continental and trachyte shids may represent the attors stage of continental-rift volcanitm; once the flux of mantle-derived magnas that bean sufficient to generate a large reason of foliate liquid that can at as a demaity filter, taffic magnas spracinetic rocks, caldersa).

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BdPO Volcanology
THS M.NOCEME SEMBOUNT HEREES OF LA PALMA/CHARY ISLANDS
B. Slawdigsh. Sartyps fast. of Chesnography, L. Jolin.
CA 92091 and Lemoni Bohorty Goologisti Unsarwatory.
Palisadas, Mf 10964, and H.-V. Scheinobe, Nukr Universities, Smattol Fee Minoralogis, B-468 Bochum. FRO
A Plocans terlet of schemeits altail bassisle
pillow lawes, hydroclastitia, and breeles (Al. a
thesiad dibs warm 181 and a besal unit aig gabhro sed
clicansflo rocks [C] from Le Pains (Canary Initedni is
interpreted to a wrong-testion through on uplifted
seamount. This various has been tilled to lit present
orientstico of 10°/21°0 jplungs and asimath, probable
by nywarping during interaction of tills and platens in
the central portion of the lised. The besal pluncolosuite [C] in overlain by more them 1800 m of sill; (B),
with minor treess of lawes and bracelet. Entractives
144 force a 1800 m inter sequence of pillow lawes, hreetian, and hydroclastites. The visative richs increase
to abundance upward and art of four min types; (1)
yiling Pressial, tomainting of party broken pillow;
fressent braceles, and 31 hydroclasting componed dowinsuit of bigbly vesicular inpill and soft stand
thards are thought to have formed by set austrace
explosive aragilous, and vers subsequently iransported
downstops by mass flow, iff and 11 being interpreted
to have been rearred minist. Pillow gapris braceles (4)
from the upper 700 m of the attraive testion consistting of amucholdes, bigbly vesicular "pillow!" and
investing frame for accounting the subsequent and soft of both suppers of beet formed by starting envisioning (4)
from the upper 700 m of the attraive testion consistting of amucholdes, bigbly vesicular "pillow!" and
investing frame for accounting the subsequent and soft of brace and for a semionic soft and the selection of soft
party attractive accounting the processes in approximation, sombined with evidence
from autface studies of reasonate vesicular and depositions, and for assemil or slopes resisted to the
semional are formed by lar J. Geophys. Res., C. Paper 4d070f

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roccan basin (bosed on the data of the 32nd cruise of the R/V «Akodemik Kur-

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Neprochnooa A. F., Shishkina N. A. Peculiartiles of the seismic wave fields and the alruchure of the Earth's crual in the central part of the East Indian Ridge
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Gol perin M. V. A simulation sludy of a louting community: restization on the campuler

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To the memory of Sergey Illorionovich Ushakov (8 October, 1908—10 June, 1982) 717
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